



June 13, 2014

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Re: *Chlorobenzene Area Remedial Approach Report, UCC South Charleston Facility, South Charleston, West Virginia*

Dear Mr. Weissbart:

Enclosed for your review and approval is the *Chlorobenzene Area Remedial Approach Report (RAR)* at the Union Carbide Corporation (UCC) South Charleston Facility in South Charleston, West Virginia. The objective of this RAR is to document the remediation path forward and overall strategy for the Chlorobenzene Area.

If you have any questions or would like to discuss this document further, please feel free to call me at (513) 847-4487.

Sincerely,

A handwritten signature in black ink that reads "Eric J. Kroger".

Eric Kroger
CH2M HILL
Site Lead

Enclosures

cc: Catherine Guynn/WVDEP
Jerome Cibrik/UCC Remediation Leader
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Report

Chlorobenzene Remediation Area Remedial Approach South Charleston Facility South Charleston, West Virginia

Prepared for
Union Carbide Corporation

June 2014

CH2MHILL.

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Acronyms and Abbreviations

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
amsl	above mean sea level
AS/B	air sparge/biosparge
bgs	below ground surface
CHP	catalyzed hydrogen peroxide
ClB Area	Chlorobenzene Remediation Area
CIH Area	Chlorhydrin Remediation Area
COC	constituent of concern
COPC	constituent of potential concern
CSM	conceptual site model
DCB	1,4-dichlorobenzene
DPT	direct-push technology
Facility	South Charleston Facility, South Charleston, West Virginia
Fe ²⁺	ferrous iron
GAC	granular activated carbon
H ₂ O ₂	hydrogen peroxide
HI	hazard index
ISCO	in situ chemical oxidation
mg/kg	milligrams per kilogram
MnO ₄ ⁻	permanganate
NAPL	nonaqueous phase liquid
O&M	operations and maintenance
O ₃	ozone
OA Unit	Oxide Adducts Unit
P&T	pump and treat
RAO	remedial action objective
RAR	Remedial Approach Report
RCRA	Resource Conservation and Recovery Act

ROI	radius of influence
RTO	regenerative thermal oxidizer
S ₂ O ₈ ²⁻	persulfate
scfm	standard cubic feet per minute
SEE	steam-enhanced extraction
SVE	soil vapor extraction
TCE	trichloroethylene
TCH	thermal conductive heating
TTZ	target treatment zone
UCC	Union Carbide Corporation
USEPA	United States Environmental Protection Agency
VI	vapor intrusion
VOC	volatile organic compound

SECTION 1

Introduction

This Remedial Approach Report (RAR) addresses the Chlorobenzene Remediation Area, also known as the “CIB Area,” at the Union Carbide Corporation (UCC) South Charleston Facility (hereafter referred to as the “Facility”) located in South Charleston, West Virginia. **Figure 1-1** presents an overview of the Facility and the general location of the CIB Area.

The Facility, including the CIB Area, has been in continuous chemical manufacturing since the early 1900s. UCC acquired the property in 1925 and operations since that time have included the production of various specialty chemicals. Environmental site investigations and remediation activities at the Facility are managed in accordance with the United States Environmental Protection Agency (USEPA) Region 3 Resource Conservation and Recovery Act (RCRA) Facility Lead Agreement with UCC, dated December 15, 1999. To help organize and manage remediation activities, the Facility has been divided into 10 remediation areas based on distinct groundwater plumes and the associated known or suspected source areas. One of these remediation areas is the CIB Area, which is located on the mainland near the western edge of the Facility.

On February 19, 2013, UCC and USEPA met to discuss the overall strategy for the CIB Area and agreed on the remedy approach documented in this report.

1.1 Purpose

The purpose of this report is to present:

- The conceptual site model (CSM) for the CIB Area;
- The CIB Area remedial action objectives (RAOs);
- The CIB Area target treatment zone (TTZ), i.e., area of the site where remediation will be applied to achieve the RAOs; and
- The remedies that were evaluated, the selected remedy, and its implementation.

SECTION 2

Conceptual Site Model

2.1 Site Background

The ClB Area is bordered by the Kanawha River to the north and a former chemical production facility ("Private Property") to the west (**Figure 2-1**), and is subdivided into East and West areas due to the unique characteristics of each segment. The West ClB Area extends from the western fence line to the Oxide Adducts Unit (OA Unit), and once contained a unit that produced chlorobenzene. This unit was not operated after being acquired by UCC and demolished in most probably the late 1920s. The West ClB Area currently contains an electrical substation, transmission tower, and several unoccupied support buildings to the north and a medical facility (Building 44) to the south. The East ClB Area encompasses the portion of the site currently occupied by UCC's active OA Unit.

A second chlorobenzene unit that produced similar chemicals was present south of the OA Unit and operated until the early 1920s. This chlorobenzene unit was located outside the ClB Area (within the current boundary of the Chlorhydrin Remediation Area [ClH]) and upgradient of the East ClB Area (**Figure 2-1**). UCC constructed an olefins unit in this structure in the mid-1920s, which manufactured ethylene, propylene, and acetylene until it was demolished prior to 1950. UCC never operated the chlorobenzene unit prior to its conversion to an olefins unit and subsequent demolition.

2.2 Topography

The ClB Area is relatively flat because of historical demolition and grading activities, with a current ground surface elevation of approximately 600 feet above mean sea level (amsl). Immediately to the north is a steep riverbank that drops down to the Kanawha River (pool elevation of approximately 565 feet amsl). The northwestern corner of the West ClB Area is approximately 20 feet higher in elevation than the adjoining private property. This is the differential between the ground surface in the West ClB Area and the bottom of the former building structure on the adjoining property. The two areas are separated by a concrete retaining wall.

2.3 Geology and Hydrology

The geologic units of the ClB Area are shown on a cross section in **Figure 2-2** (plan view of cross section is shown on **Figure 2-1**). The upper 5 to 20 feet consist of fill material containing construction debris mixed with reworked sand, gravel, and clay. Beneath the fill material, a clay layer containing some sand and silt seams extends to a depth of approximately 30 feet below ground surface (bgs). This unit represents the unsaturated (vadose) zone. From 30 to 35 feet bgs, the subsurface geology becomes highly heterogeneous across the ClB Area. Laterally continuous and discontinuous interbedded silty to clayey sands with varying degrees of saturation are present within this depth

interval. This heterogeneity is most pronounced beneath the northwestern portion of the West CIB Area.

A sandy aquifer is present below the interbedded silty to clayey sand from approximately 35 feet bgs to bedrock, and is confined throughout most of the site. The underlying bedrock is comprised of weathered sandstone that grades into competent sandstone at approximately 60 feet bgs. The depth to groundwater at the CIB Area is approximately 32 feet bgs, and groundwater flows to the northeast toward the Kanawha River. Perched water is present in some of the silty/sandy lenses within and above the clay unit.

2.4 Nature and Extent of Contamination

Investigative activities took place at the CIB Area from 2006 to 2013 to characterize potential soil, groundwater, and pore water impacts, and associated source areas. The majority of the investigations occurred in the West CIB Area, with limited sampling conducted in the East CIB Area due to access restrictions in the OA Unit. In addition, limited investigation work was conducted in the northern portion of West CIB Area due to the limitations of working near the transmission tower and support buildings.

During the investigation work, 17 monitoring wells were installed and sampled, and 82 soil and 31 grab groundwater samples were collected from 54 vertical and three angled soil borings. Each vertical boring was installed on UCC property. Two of the angled borings were advanced beneath the adjacent private property and one angled boring was advanced towards the Kanawha River. In 2008, a total of 22 pore water samples were collected north of the CIB Area to characterize impacts in the Kanawha River. The data collected during these investigations have characterized the nature and extent of contamination at the site, and are appropriate for use in selecting the remedy for the CIB Area. The sampling locations within the CIB Area are shown on **Figure 2-1**, and analytical soil and groundwater data are presented in **Table 2-1** and **Table 2-2**, respectively.

Angled borings 4103 and 4104 were installed toward the western property boundary using a truck-mounted sonic drill rig. The borings were started approximately 40 feet from the fence line, with the subsurface traverses of the angled borings shown in **Figure 2-1**. The target depth was approximately 60 vertical feet bgs (on the adjacent property), which is the average depth of bedrock beneath the UCC property. Angles of 43 degrees (boring 4103) and 42 degrees (boring 4104) were chosen to reach the target depth at a horizontal distance of approximately 25 feet beyond the fence line. A 33-degree angle was selected for the third angled boring (boring 4100) to reach the target depth beneath the riverbed.

2.4.1 Pore Water Cleanup Levels

Relative to the facility RAOs discussed in Section 3, UCC has developed pore water cleanup levels to be protective of potential Kanawha River exposure pathways for human and ecological receptors. The processes, analytical data, and calculations used to develop these criteria are presented in the *Revised Pore Water Cleanup Levels and Groundwater Performance Criteria Report* (CH2M HILL 2009a), which was approved by USEPA on July 31, 2009, and the *Facility-Wide Pore Water Characterization Report* (CH2M HILL 2013). Within the subsequent sections and associated figures, the pore water cleanup levels are compared to concentrations in groundwater (Section 2.4.2) and pore water (Section 2.4.3), but are not

applicable for soil comparisons (Section 2.4.1). The constituents of concern (COCs) within the ClB Area and their associated pore water cleanup criteria are as follows (CH2M HILL 2009b):

- 1,4-Dichlorobenzene (DCB): 15 micrograms per liter ($\mu\text{g}/\text{L}$)
- Chlorobenzene: 64 $\mu\text{g}/\text{L}$
- Benzene: 130 $\mu\text{g}/\text{L}$
- Trichloroethene (TCE): 47 $\mu\text{g}/\text{L}$

2.4.2 Impacts to Soil

Results of the investigation work show that COCs detected in soil within the ClB Area consist primarily of volatile organic compounds (VOCs) and include chlorobenzene, 1,4-DCB, and benzene. The highest concentrations of these COCs range from 1,000 to 700,000 milligrams per kilogram (mg/kg), and are present in the northwestern portion of the West ClB Area. Nonaqueous phase liquid (NAPL) has been observed in this area as droplets in soil, primarily within the upper fill and clay in several borings in the ClB Area. Samples of soil impacted with NAPL have been analyzed and identified 1,4-DCB as the primary constituent. Although soil sampling was not conducted beneath the transmission tower and support buildings (due to limited access), the surrounding sample locations indicate that the soil beneath these structures is likely impacted with chlorobenzene and 1,4-DCB. **Figure 2-3** and **Figure 2-4** show the soil boring locations and soil concentrations for chlorobenzene and 1,4-DCB, respectively, within the ClB Area.

2.4.3 Impacts to Groundwater

Results from the groundwater sampling investigations show that the primary COCs in groundwater detected in the ClB Area are chlorobenzene, 1,4-DCB, benzene, and TCE. Concentrations of chlorobenzene, 1,4-DCB, and benzene are the highest (and exceed pore water cleanup criteria) in the northwestern corner of the West ClB Area and range between several hundred $\mu\text{g}/\text{L}$ to more than 10,000 $\mu\text{g}/\text{L}$. Although access limitations prevented groundwater sampling beneath the transmission tower and support buildings, the surrounding sample locations indicate that the groundwater beneath these structures is likely impacted. Concentrations of these COCs decrease by an order of magnitude or more to the east and within the East ClB Area. **Figure 2-5** and **Figure 2-6** display the groundwater sample locations and concentrations of chlorobenzene and 1,4-DCB, respectively, in groundwater at the ClB Area.

2.4.4 Impacts to Kanawha River Pore Water

Twenty-two pore water samples were collected from the Kanawha River in 2008 north (downgradient) of the ClB Area. The constituents that most frequently exceeded pore water cleanup levels were 1,4-DCB and ClB; the highest concentrations of these ranged from several hundred $\mu\text{g}/\text{L}$ to 17,000 $\mu\text{g}/\text{L}$ measured in samples collected north of the West ClB Area at near-shore locations. Chlorobenzene and 1,4-DCB were measured at lower concentrations in samples collected to the east, but still exceeded pore water cleanup levels. Benzene also exceeded pore water cleanup levels within the same sample set but at lower concentrations. TCE was not detected within any of the pore water samples. **Figure 2-5** and **Figure 2-6** display the pore water sample locations and concentrations of chlorobenzene and

1,4-DCB, respectively, within the Kanawha River. The pore water analytical data are included in the *Kanawha River Investigation Report* (CH2M HILL 2009a).

2.4.5 Air Sparge/Biosparge Pilot Testing

From May 2010 through June 2011, an air sparge/biosparge (AS/B) pilot test was conducted within the northwest corner of the West ClB Area where the highest soil and groundwater concentrations and residual NAPL are present. The pilot test utilized four AS wells to biodegrade and strip COCs from the groundwater-bearing zones, and six soil vapor extraction (SVE) wells to alleviate pressure within the aquifer. The AS/SVE blowers were housed within an enclosed trailer, and the SVE effluent vapor was treated prior to discharge using granular activated carbon (GAC) drums. The system operated for 10 months and showed promising results in reducing VOC concentrations in groundwater.

SECTION 3

Remedial Action Objectives

3.1 Remedial Action Objectives

USEPA-approved RAOs were developed for the Facility and established in accordance with the RCRA framework to be protective of human health and the environment (CH2M HILL 2009b). Based on those Facility RAOs as well as on CIB Area-specific conditions, the following RAOs have been retained for the CIB Area:

- Clean up soil and groundwater to levels resulting in acceptable groundwater discharge to the Kanawha River.
- Address vapor intrusion risks with active soil/groundwater remediation or engineering controls, as appropriate.
- Prevent unacceptable direct contact with soil and groundwater through engineering and/or institutional controls (e.g., soil management plan).

To satisfy the first RAO, active remediation will be conducted in the West CIB Area where the highest soil and groundwater concentrations have been measured. The goal of conducting active remediation in this area is to reduce pore water concentrations in the Kanawha River and prevent impacted groundwater from migrating toward the East CIB Area.

Additional characterization cannot be conducted in the East CIB Area due to the active OA Unit. The investigative activities that were performed have not identified a source for the groundwater plume beneath this area of the site. It is possible that this plume is migrating from the West CIB Area. A groundwater monitoring program will be implemented to evaluate the effects of the active remediation of the West CIB Area, and the need for active remediation in the East CIB Area will be revisited in the future relative to the RAOs.

One occupied building (Building 44) is located in the southwestern corner of the CIB Area. Vapor intrusion (VI) risks were evaluated for Building 44; associated carcinogenic risk estimates were within USEPA's risk management range and noncancer hazard indices (HIs) were below the threshold of 1.0 (CH2M HILL 2010a). No other occupied buildings are located within the CIB Area; however, to satisfy the second RAO, vapor control systems will be used in any future constructed buildings to prevent unacceptable VI risks. To address the third RAO, institutional controls will be implemented on a site-wide basis to prevent direct exposure of human receptors to soil and groundwater.

3.2 West Area Target Treatment Zone

The area in which active remediation will be conducted in order to achieve RAOs is referred to as the Target Treatment Zone (TTZ). For the West CIB Area, the TTZ was defined based on observed pore water clean-up level exceedances, and the soil and groundwater contamination that appears related to them. Remediation within this TTZ is expected to

result in pore water concentrations that are protective of the river ecology. Note that the TTZ can be expanded if system operation over time does not achieve this objective.

The soil remediation TTZ encompasses approximately 0.60 acres and includes areas where residual NAPL has been observed in isolated areas and where soil concentrations exceed 10,000 micrograms per kilogram ($\mu\text{g}/\text{kg}$) of 1,4-DCB and 1,000 $\mu\text{g}/\text{kg}$ of chlorobenzene. This TTZ also includes the area beneath the transmission line and support buildings. The soil TTZ consists of the clayey soils overlying the aquifer that serve as a primary source area for the chlorinated benzene plumes. The thickness of this zone spans from approximately 12 feet bgs (bottom of the surficial fill) to 35 feet bgs (bottom of clay). The groundwater TTZ includes areas where groundwater within the sandy aquifer (approximately 35 to 60 feet bgs) exceeds 100 $\mu\text{g}/\text{L}$ of chlorobenzene and 1,4-DCB, and consists of an approximate 0.20-acre area that bisects the soil TTZ, and a small area to the northwest that includes groundwater beneath Building 8482. **Figure 3-1** shows the soil and groundwater TTZs. The soil and groundwater concentrations used to arrive at this TTZ are shown in **Figures 2-3** and **2-4** (soil), and **Figures 2-5** and **2-6** (groundwater).

3.3 West Area Remedy Selection Challenges

During the remedy selection process, there were several challenges to evaluate and consider for the West ClB Area:

- The primary source of VOCs is primarily contained in fine-grained clayey soils overlying the aquifer.
- A vadose zone is present in the clay but has low permeability to air.
- The chlorobenzene and 1,4-DCB plume source is near the Kanawha River, offering little time for VOCs in groundwater to naturally attenuate prior to discharging to the river.

SECTION 4

Remedy Evaluation Selection

4.1 Remedy Screening

Potential remedies selected for evaluation, based on the RAOs in Section 3.1, are described in this section. The remedial technology screening for the CIB Area is provided in **Table 4-1**. Technologies carried forward were evaluated using the following screening criteria:

- Effectiveness
- Implementability
- Relative Cost Range

The selected remedy for the site based on the remedy evaluation is presented in Section 4.3.

4.2 Remedial Alternatives

Five potential remedial alternatives were selected for evaluation, as described below, comprising soil fracturing with AS/SVE, thermal conductive heating (TCH) and steam enhanced extraction (SEE), hydraulic containment via pump and treat (P&T), in situ chemical oxidation (ISCO), and excavation.

4.2.1 Alternative 1 – Soil Fracturing with Air Sparge/Soil Vapor Extraction (AS/SVE)

This alternative consists of fracturing the low-permeability clay using a hybrid method of pneumatic fracturing and injection of sand/guar gum proppant, followed by the installation of an AS/SVE network. The AS network will inject air into the water-bearing aquifer to remove VOCs from the groundwater. The SVE system will extract VOCs from the fractured clayey zone source area and alleviate pressure from the water-bearing zones where AS is taking place. Angled AS/SVE wells will be installed beneath the transmission line and support buildings to address potential impacts in this area. Extracted vapors will be treated using a regenerative thermal oxidizer.

4.2.2 Alternative 2 – Thermal Conductive Heating (TCH) and Steam Enhanced Extraction (SEE)

TCH is a physical method of heating the impacted zone using electric resistance heaters to the boiling point of liquids in the soil. As the soil is heated, water is boiled, and steam is generated and extracted along with the VOCs vaporized with the water. The SEE is used to separate and treat the COCs through wells and extraction of hot fluids. Details on the implementation are provided below:

- Heat the vadose zone and upper sand to the boiling point of water.
 - Install a continuous sealed steel casing, a heater element, and ceramic insulators across the treatment zone.

- Transfer radiant heat from the heater element to the well casing, resulting in the vaporization of water within the soil.
- Water and vapor are extracted along with VOCs vaporized with the water using SVE techniques.
- The SEE addresses groundwater in the aquifer by injecting steam, allows for extraction of hot fluids, and displaces large amounts of groundwater toward the extraction wells.

4.2.3 Alternative 3 –Containment via Pump and Treat (P&T)

This alternative consists of the installation of groundwater extraction wells to create hydraulic containment within and downgradient of the source area. The recovered contaminated groundwater is treated before being discharged. Additional details on the implementation of this alternative are provided below:

- Install extraction wells screened across the upper and lower sands. These extraction wells will create hydraulic capture zones to contain contaminated groundwater discharging to the Kanawha River pore water.
- Treat the contaminated groundwater prior to discharging to the Facility process sewer.

4.2.4 Alternative 4 –In Situ Chemical Oxidation (ISCO)

ISCO consists of injecting a chemical oxidant into the subsurface via injection wells and/or direct-push technology (DPT) so that there is direct contact between the oxidant and the COCs. ISCO results in the transformation of a wide range of environmental contaminants and enhances mass transfer. Several different forms of oxidants have been used for ISCO, although the most commonly used oxidants include the following:

- Permanganate (MnO_4^-)
- Fenton's (hydrogen peroxide [H_2O_2] and ferrous iron [Fe^{+2}]) or catalyzed hydrogen peroxide (CHP)
- Ozone (O_3)
- Persulfate ($S_2O_8^{2-}$)

Pilot-scale studies would be necessary to identify a suitable oxidant, assess site-specific feasibility, and obtain necessary design data.

4.2.5 Alternative 5 – Excavation

This alternative consists of excavating the source area soils to a depth of approximately 50 feet bgs. The source material will be hauled and disposed of at a permitted landfill facility (RCRA Subtitle C or D landfill, dependent on waste characterization results). Structural stabilization (sheet piles) adjacent to the existing buildings or demolition of existing buildings may be required.

4.3 Remedy Evaluation

Each alternative discussed in Section 4.2 was evaluated against three criteria: effectiveness, implementability, and cost range. The screening of the specific technologies is provided in **Table 4-1**.

- **Effectiveness:** Each alternative was evaluated for its effectiveness in both groundwater and soil.
 - Long-term reliability and effectiveness: Considers the long-term reliability and effectiveness afforded by the remedy. In addition, it considers the magnitude of risk that will remain at the site from residual contamination.
 - Reduction of toxicity, mobility, or volume of wastes: Considers the ability of each remedy to eliminate or reduce the toxicity, mobility, or volume of contaminated media at the site.
 - Short-term effectiveness: Considers the risks to human health and the environment until RAOs are achieved.
- Implementability: This criterion considers the degree of difficulty anticipated in implementing a particular remedy under the technical constraints posed by the site.
- **Cost:** This criterion considers the relative cost range of a remedy, including capital and long-term operations and maintenance (O&M).

Relative ratings (low, moderate, and high) are assigned to these criteria, with a rating of high being the most desirable.

4.4 Remedial Alternative Selection

4.4.1 Alternative 1 – Soil Fracturing with AS/SVE

This alternative was selected as the remedy for the West ClB area. Alternative 1 was evaluated against the effectiveness, implementability, and cost criteria. Details of the evaluation are provided below.

4.4.2 Effectiveness

This alternative has a medium-to-high effectiveness for the AS to strip VOCs from the groundwater. Possible challenges to AS are that air channeling and the presence of low-permeability lenses in the saturated zone could result in untreated areas. This alternative has a medium effectiveness for SVE to treat VOCs adsorbed to the clayey soil after fracturing. Possible challenges to SVE are back diffusion from unfractured clayey soil will prolong the remedial timeframe and limit the ability to meet cleanup criteria.

4.4.3 Implementability

This alternative can be easily implemented because the equipment, vendors, and materials are readily available. The northeastern portion of the treatment zone is not directly accessible for vertical well installation; however, angled AS wells and vent wells can be installed in that area.

4.4.4 Cost

The capital costs are medium to high, and include AS/SVE process equipment and a retrofit to existing vapor treatment equipment. The O&M costs are high due to weekly and periodic upkeep. The overall costs are relatively high; however, all alternatives screened for this treatment zone area are moderate to high in cost. The other remedial alternatives were eliminated primarily because of high costs, low implementability, and/or low effectiveness.

4.4.5 Alternative 2 – Thermal Conductive Heating (TCH) and Steam Enhanced Extraction (SEE)

Alternative 2 (TCH and SEE) has a high effectiveness in groundwater (SEE), while TCH works well in tight soils. This alternative was not selected because of low implementability around existing structures and high cost.

4.4.6 Alternative 3 –Containment via Pump and Treat (P&T)

Alternative 3 (containment via P&T) has high effectiveness in hydraulic containment of groundwater, but it will not treat the source area contamination in the clayey soil. This alternative has a high cost because a treatment system would have to be installed to pre-treat extracted groundwater prior to discharge to the process sewer. Because this alternative would not address the source, it would have to be implemented indefinitely. This alternative was not selected.

4.4.7 Alternative 4 – ISCO

Alternative 4 (ISCO) has a medium-to-high effectiveness in degrading dissolved chlorinated benzenes in groundwater, but is less effective in addressing residual, isolated NAPL. ISCO would be less effective in treating the source area in the clayey soil; soil fracturing could be included, but distributing the oxidant throughout the clayey soil could be problematic even in fractured clay. The cost is medium to high, and would likely involve multiple applications of the oxidant. Because of these factors, Alternative 4 was not selected.

4.4.8 Alternative 5 – Excavation

Alternative 5 (source excavation and disposal) requires either sheet piling or excessive overburden removal and subsequent backfilling for benching or sloping to reach the treatment depth; both methods for reaching the target depth are costly. This alternative would require excavating to a depth of approximately 30 feet bgs to remove the source area soils, and to depths exceeding 50 feet bgs to remove areas of significant impacts within the aquifer. Alternative 5 is not practical given the proximity to the river and the adjacent property, and, therefore, was not selected.

SECTION 5

Implementation of the Selected Remedy

Alternative 1 was selected as the remedy for the West ClB Area and will be implemented in the soil and groundwater TTZs shown on **Figure 3-1**. No active chemical process units are present within these TTZs; however, an active electrical tower and support buildings are located in the northeastern portion of the site. The subsurface cannot be accessed directly in this area, and instead, angled drilling techniques will be used to install remediation wells beneath most structures.

SVE will be implemented within the soil TTZ, which represents the area where concentrations of 1,4-DCB in soil are greater than 10,000 µg/kg, concentrations of ClB in soil are greater than 1,000 µg/kg, or where residual NAPL has been observed. The lateral extent of the soil TTZ is approximately 0.6 acres. Vertically, the soil TTZ is limited to the clay layer, from approximately 12 feet bgs (below non-impacted fill material) to approximately 35 feet bgs. To provide secondary permeability in fine-grained soils, soil fracturing will be implemented at each SVE well location before installation of each SVE well, with the exception of SVE wells located near or beneath buildings or the property boundary.

SVE wells will be installed to collect soil vapors from fine-grained soils in the vadose zone and perched sand lenses contained within the fine-grained soils. SVE wells from past remediation efforts at the Facility were installed at 30-foot intervals. Operation at these systems showed that the radius of influence (ROI) for fractured SVE wells was typically greater than 15 feet, and in some cases, induced vacuum was observed at the extent of the subsurface fracture network. These results indicate a non-uniform but relatively extensive fracture network can be established using this method. In addition, the fracturing appears to have resulted in highly variable radii and direction of fracture orientation from individual SVE wells, but likely provides overall coverage of the low-permeability unit through the operation of a network of SVE wells whose fracture-induced airflow pathways intersect randomly. Therefore, a vacuum ROI for SVE wells at the ClB Area is estimated to be 15 feet, with wells generally spaced 25 feet apart to create overlap within the TTZ. A maximum SVE design flow rate of 10 standard cubic feet per minute (scfm) is assumed per SVE well. The SVE flow rate is based on an assumption of approximately 1 scfm per foot of well screen. The flow rates for individual wells will be adjusted to balance the SVE system and optimize remediation activities.

AS will be implemented within the groundwater TTZ where dissolved ClB and 1,4-DCB concentrations are greater than 100 µg/L. The lateral extent of the groundwater TTZ is approximately 0.2 acres. Vertically, the groundwater TTZ extends from the top of the sandy aquifer at approximately 35 feet bgs and extends to bedrock (approximately 55 feet bgs). In addition, impacted shallow saturated sand units have been encountered within the northern portion of the site. Deep AS wells will be installed across the groundwater TTZ to bedrock and shallow AS wells will be installed as needed and where continuous shallow saturated sand units are present. A 30-foot AS ROI was observed during past pilot testing and full-scale operation at the Facility, and will be implemented here as well. The estimated design

flow rate for each AS well is 3 to 5 scfm at injection pressures that range from 3 to 14 pounds per square inch gauge.

Vent wells will be installed across the soil and groundwater TTZs to relieve pressure in the saturated sand under the clay layer and capture VOCs stripped from the saturated sand aquifer. Vent wells generally are spaced in a triangular pattern around each AS well, resulting in three vent wells within the expected ROI of each AS well. Vent wells are spaced more densely along the perimeter of the TTZ to reduce the potential offsite effects of a pressure gradient and potential for migration of impacted groundwater or vapor.

Additional vent wells will be considered, as necessary, based on performance monitoring data during system operation. A low vacuum will be applied to the vent wells to promote vapor control from the vent wells to the process and treatment system, and maintain a net negative pressure in the conveyance piping. The vacuum is expected to be 1 inch of mercury or less. In addition to the installation of the AS/SVE remediation system, additional monitoring wells and vapor monitoring probes will be installed within or adjacent to the TTZs. These wells will enhance the groundwater and field parameter evaluation.

Process vapor from the ClB Area will be conveyed to the existing CIH Area regenerative thermal oxidizer (RTO) for treatment. The layout of the SVE wells, AS wells, vent wells, monitoring wells, and vapor monitoring probes is shown on **Figure 2-1**.

5.1 Long-Term Groundwater Monitoring

Groundwater monitoring will be performed in the West Area by sampling a subset of the 28 new and existing monitoring wells to assess changes in groundwater concentrations over time during remediation. Groundwater monitoring in the East Area will be performed by sampling the four existing monitoring wells to assess the effects of the active remediation in the West Area. Sampling will be conducted every 9 months and as needed in the West Area, and every 9 months in the East Area. Additional details for the groundwater monitoring plan will be included within the O&M plan, and modifications to this plan will be communicated annually to USEPA.

SECTION 6

Performance Metrics

The performance metrics for this remedy are used to reinforce the RAOs (provided in Section 3.1). These metrics include the following:

- Groundwater concentrations will be monitored during remediation to determine if sufficient cleanup has been conducted relative to pore water cleanup levels.
- Performance data will be used to track runtime efficiency and calculate mass removal as performance metrics for operations of the system. These metrics will be routinely evaluated to make system adjustments and optimize system performance.

SECTION 7

References

CH2M HILL. 2009a. *Kanawha River Investigation Report*. UCC South Charleston Facility, South Charleston, West Virginia.

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CH2M HILL. 2010a. *2010 Vapor Intrusion Risk Assessment Report, South Charleston Facility, South Charleston, West Virginia*. December.

CH2M HILL. 2013. *Facility-Wide Pore Water Characterization Report*, South Charleston Facility, South Charleston, West Virginia. October.

Tables

Table 2-1
 Summary of Chemicals Detected in Soil
 Union Carbide Corporation South Charleston Facility
 Remedial Approach Report

Analyte	Property		Angled Towards River			Angled towards FMC			angled towards FMC		
	Location>>	Dow	River	River	Dow	Dow	FMC	Dow	FMC	FMC	
		Sample ID>>	4100	4100	4100	4103	4103	4103	4104	4104	
		Sample Depth (m)>>	34.5 - 35	36.5 - 37	110.5 - 111	11.5 - 12	3.5 - 4	48 - 48.5	18.5 - 19	48 - 49	
		Sample Date>>	8/8/2011	8/8/2011	8/9/2011	8/13/2011	8/13/2011	8/13/2011	8/25/2011	8/25/2011	
Metal	Units	Minimum Screening Level	--	--	--	--	--	--	--	--	
Total Organic Carbon by SW846-9060	MG/KG	NA	--	--	--	--	--	--	--	--	
VOC											
1,1,1-Trichloroethane	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
1,1,2,2-Tetrachloroethane	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
1,1,2-Trichloroethane	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
1,1-Dichloroethane	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
1,1-Dichloroethene	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
1,2,4-Trichlorobenzene	ug/kg	NA	27,900 SU	11,200 SU	14,800 S	89,400 S	6.08 SU	10.3 S	602,000 S	6.54 SU	
1,2-Dichlorobenzene	ug/kg	NA	27,900 SU	94,700 S	7,220 S	5,100 SU	6.08 SU	136 S	128,000 S	6.54 SU	
1,2-Dichloroethane	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
1,2-Dichloropropane	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
1,3-Dichlorobenzene	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
1,4-Dichlorobenzene	ug/kg	NA	624,000 S	237,000 S	11,700 S	5,100 SU	6.08 SU	361 SJ	228,000 S	6.54 SU	
1,4-Dioxane (p-Dioxane)	ug/kg	NA	9,480,000 SU	3,820,000 SU	242,000 SU	1,740,000 SU	2,070 SU	2,040 SU	17,900,000 SU	2,230 SU	
2-Butanone	ug/kg	NA	139,000 SU	56,200 SU	3,550 SU	25,500 SU	30.4 SU	30.1 SU	264,000 SU	32.7 SU	
2-Hexanone	ug/kg	NA	55,700 SU	22,500 SU	1,420 SU	10,200 SU	12.2 SU	12 SU	106,000 SU	13.1 SU	
4-Methyl-2-pentanone	ug/kg	NA	55,700 SU	22,500 SU	1,420 SU	10,200 SU	12.2 SU	12 SU	106,000 SU	13.1 SU	
Acetone	ug/kg	NA	557,000 SU	225,000 SU	14,200 SU	102,000 SU	122 SU	120 SU	1,060,000 SU	131 SU	
Acrylonitrile	ug/kg	NA	557,000 SU	225,000 SU	14,200 SU	102,000 SU	122 SU	120 SU	1,060,000 SU	131 SU	
Benzene	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	50.6 S	52,800 SU	40.6 S	
Bromodichloromethane	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
Bromoform	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
Bromomethane	ug/kg	NA	55,700 SU	22,500 SU	1,420 SU	10,200 SU	12.2 SU	12 SU	106,000 SU	13.1 SU	
Carbon disulfide	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
Carbon tetrachloride	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
Chlorobenzene	ug/kg	NA	27,900 SU	11,200 SU	1,400 S	5,100 SU	6.08 SU	194 S	52,800 SU	109 S	
Chloroethane	ug/kg	NA	55,700 SU	22,500 SU	1,420 SU	10,200 SU	12.2 SU	12 SU	106,000 SU	13.1 SU	
Chloroform	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
Chloromethane	ug/kg	NA	55,700 SU	22,500 SU	1,420 SU	10,200 SU	12.2 SU	12 SU	106,000 SU	13.1 SU	
cis-1,2-Dichloroethylene	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
cis-1,3-Dichloropropene	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
Dibromochloromethane	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
Ethylbenzene	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
Methylene chloride	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
Styrene	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
tert-Butyl Methyl Ether	ug/kg	NA	55,700 SU	22,500 SU	1,420 SU	10,200 SU	12.2 SU	12 SU	106,000 SU	13.1 SU	
Tetrachloroethene	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
Toluene	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
Trans-1,2-Dichloroethylene	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
trans-1,3-Dichloropropene	ug/kg	NA	27,900 SU	11,200 SU	711 SU	5,100 SU	6.08 SU	6.01 SU	52,800 SU	6.54 SU	
Trichloroethylene	ug/kg	NA	27,900 SU	11,200 SU	1,900 S	5,100 SU	6.08 SU	24.6 S	52,800 SU	6.54 S	
Vinyl acetate	ug/kg	NA	55,700 SU	22,500 SU	1,420 SU	10,200 SU	12.2 SU	12 SU	106,000 SU	13.1 SU	
Vinyl chloride	ug/kg	NA	55,700 SU	22,500 SU	1,420 SU	10,200 SU	12.2 SU	12 SU	106,000 SU	13.1 SU	
VOCs, Total	ug/kg	NA	624,000	331,700	37,020	89,400	0 U	776.5	958,000	149.6	
Xylenes, Total	ug/kg	NA	55,700 SU	22,500 SU	1,420 SU	10,200 SU	12.2 SU	12 SU	106,000 SU	13.1 SU	

Table 2-1

Summary of Chemicals Detected in Soil

Union Carbide Corporation South Charleston Facility

Remedial Approach Report

Analyte	Property		Dow									
	Units	Minimum Screening Level	Location>>	4104	FMC	4105	Dow	Dow	Dow	Dow	Dow	Dow
			Sample ID>>	4104-SO01-082511	4104-SO01-082611	4105-SO01-072211	4105-SO02-072211	4105-SO03-072211	4105-SO04-072211	4106-SO02-101711	4106-SO01-101711	4106-SO03-101711
			Sample Depth (m)>>	8.5 - 9	90 - 91	27.5 - 28	38.5 - 39.5	40 - 41	44 - 45	20 - 20.5	23.5 - 24	37 - 38
Metal			Sample Date>>	8/25/2011	8/26/2011	7/22/2011	7/22/2011	7/22/2011	7/22/2011	10/17/2011	10/17/2011	10/17/2011
Total Organic Carbon by SW846-9060	MG/KG	NA	--	--	--	1,170 SU	1,210 SU	1,310 SU	--	--	6,360 S	
VOC	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
1,1,1-Trichloroethane	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
1,1,2,2-Tetrachloroethane	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
1,1,2-Trichloroethane	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
1,1-Dichloroethane	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
1,1-Dichloroethene	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
1,2,4-Trichlorobenzene	ug/kg	NA	4.94 SU	492 SU	2,720 S	--	--	--	15,900 S	6,020 S	--	
1,2-Dichlorobenzene	ug/kg	NA	4.94 SU	492 SU	3,130 S	--	--	--	30,600 S	6,060 S	--	
1,2-Dichloroethane	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
1,2-Dichloropropane	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
1,3-Dichlorobenzene	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
1,4-Dichlorobenzene	ug/kg	NA	4.94 SU	492 SU	7,790 S	--	--	--	47,200 S	11,300 S	--	
1,4-Dioxane (p-Dioxane)	ug/kg	NA	1,680 SU	167,000 SU	195,000 SU	--	--	--	1,620,000 SU	346,000 SU	--	
2-Butanone	ug/kg	NA	24.7 SU	2,460 SU	2,860 SU	--	--	--	23,800 SU	5,090 SU	--	
2-Hexanone	ug/kg	NA	9.89 SU	984 SU	1,140 SU	--	--	--	9,520 SU	2,040 SU	--	
4-Methyl-2-pentanone	ug/kg	NA	9.89 SU	984 SU	1,140 SU	--	--	--	9,520 SU	2,040 SU	--	
Acetone	ug/kg	NA	98.9 SU	9,840 SU	11,400 SU	--	--	--	95,200 SU	20,400 SU	--	
Acrylonitrile	ug/kg	NA	98.9 SU	9,840 SU	11,400 SU	--	--	--	95,200 SU	20,400 SU	--	
Benzene	ug/kg	NA	4.94 SU	492 SU	807 S	--	--	--	4,760 SU	1,020 SU	--	
Bromodichloromethane	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
Bromoform	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
Bromomethane	ug/kg	NA	9.89 SU	984 SU	1,140 SU	--	--	--	9,520 SU	2,040 SU	--	
Carbon disulfide	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
Carbon tetrachloride	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
Chlorobenzene	ug/kg	NA	4.94 SU	492 SU	6,320 S	--	--	--	21,800 S	5,440 S	--	
Chloroethane	ug/kg	NA	9.89 SU	984 SU	1,140 SU	--	--	--	9,520 SU	2,040 SU	--	
Chloroform	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
Chloromethane	ug/kg	NA	9.89 SU	984 SU	1,140 SU	--	--	--	9,520 SU	2,040 SU	--	
cis-1,2-Dichloroethylene	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
cis-1,3-Dichloropropene	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
Dibromochloromethane	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
Ethylbenzene	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	19,100 S	8,480 S	--	
Methylene chloride	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
Styrene	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	41,900 S	3,580 S	--	
tert-Butyl Methyl Ether	ug/kg	NA	9.89 SU	984 SU	1,140 SU	--	--	--	9,520 SU	2,040 SU	--	
Tetrachloroethene	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
Toluene	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	7,030 S	1,770 S	--	
Trans-1,2-Dichloroethylene	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
trans-1,3-Dichloropropene	ug/kg	NA	4.94 SU	492 SU	572 SU	--	--	--	4,760 SU	1,020 SU	--	
Trichloroethylene	ug/kg	NA	4.94 SU	379 SJ	572 SU	--	--	--	4,760 SU	1,020 SU	--	
Vinyl acetate	ug/kg	NA	9.89 SU	984 SU	1,140 SU	--	--	--	9,520 SU	2,040 SU	--	
Vinyl chloride	ug/kg	NA	9.89 SU	984 SU	1,140 SU	--	--	--	9,520 SU	2,040 SU	--	
VOCs, Total	ug/kg	NA	0 U	379	20,767	--	--	--	217,930	46,680	--	
Xylenes, Total	ug/kg	NA	9.89 SU	984 SU	1,140 SU	--	--	--	34,400 S	4,030 S	--	

Table 2-1

Summary of Chemicals Detected in Soil
 Union Carbide Corporation South Charleston Facility
 Remedial Approach Report

Analyte	Property		Dow	Dow	Dow	Dow	Dow	Dow	Dow	Dow	Dow
	Units	Minimum Screening Level	Location>>	4106	4107	4107	4108	4108	4108	4109	4109
			Sample ID>>	4106-SO04-101711	4107-SO01-102611	4107-SO02-102611	4108-SO01-102411	4108-SO02-102411	4108-SO03-102411	4108-SO04-102411	4109-SO01-101911
			Sample Depth (m)>>	39 - 40	13 - 13.5	16.5 - 17	10 - 10.5	30 - 30.5	31 - 32	33 - 34	22.5 - 23
			Sample Date>>	10/17/2011	10/26/2011	10/26/2011	10/24/2011	10/24/2011	10/24/2011	10/24/2011	10/19/2011
Metal											
Total Organic Carbon by SW846-9060	MG/KG	NA		8,960 S	--	--	--	--	1,990 S	2,530 S	--
VOC											
1,1,1-Trichloroethane	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
1,1,2,2-Tetrachloroethane	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
1,1,2-Trichloroethane	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
1,1-Dichloroethane	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
1,1-Dichloroethene	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
1,2,4-Trichlorobenzene	ug/kg	NA	--	141,000 S	313,000 S	4.9 SU	606 SU	--	--	842 S	587 SU
1,2-Dichlorobenzene	ug/kg	NA	--	11,800 S	28,300 S	4.9 SU	9,680 S	--	--	5,150 S	3,210 S
1,2-Dichloroethane	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
1,2-Dichloropropane	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
1,3-Dichlorobenzene	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
1,4-Dichlorobenzene	ug/kg	NA	--	21,300 S	53,600 S	4.9 SU	13,000 S	--	--	5,740 S	3,500 S
1,4-Dioxane (p-Dioxane)	ug/kg	NA	--	1,930,000 SU	4,050,000 SU	1,670 SU	206,000 SU	--	--	225,000 SU	200,000 SU
2-Butanone	ug/kg	NA	--	28,400 SU	59,500 SU	24.5 SU	3,030 SU	--	--	3,300 SU	2,940 SU
2-Hexanone	ug/kg	NA	--	11,400 SU	23,800 SU	9.8 SU	1,210 SU	--	--	1,320 SU	1,170 SU
4-Methyl-2-pentanone	ug/kg	NA	--	11,400 SU	23,800 SU	9.8 SU	1,210 SU	--	--	1,320 SU	1,170 SU
Acetone	ug/kg	NA	--	114,000 SU	238,000 SU	98 SU	12,100 SU	--	--	13,200 SU	11,700 SU
Acrylonitrile	ug/kg	NA	--	114,000 SU	238,000 SU	98 SU	12,100 SU	--	--	13,200 SU	11,700 SU
Benzene	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	1,530 S	6,470 S
Bromodichloromethane	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
Bromoform	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
Bromomethane	ug/kg	NA	--	11,400 SU	23,800 SU	9.8 SU	1,210 SU	--	--	1,320 SU	1,170 SU
Carbon disulfide	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
Carbon tetrachloride	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
Chlorobenzene	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	1,910 S	--	--	2,570 S	8,260 S
Chloroethane	ug/kg	NA	--	11,400 SU	23,800 SU	9.8 SU	1,210 SU	--	--	1,320 SU	1,170 SU
Chloroform	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
Chloromethane	ug/kg	NA	--	11,400 SU	23,800 SU	9.8 SU	1,210 SU	--	--	1,320 SU	1,170 SU
cis-1,2-Dichloroethylene	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
cis-1,3-Dichloropropene	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
Dibromochloromethane	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
Ethylbenzene	ug/kg	NA	--	15,700 S	48,100 S	4.9 SU	606 SU	--	--	660 SU	587 SU
Methylene chloride	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
Styrene	ug/kg	NA	--	6,270 S	18,300 S	4.9 SU	606 SU	--	--	660 SU	587 SU
tert-Butyl Methyl Ether	ug/kg	NA	--	11,400 SU	23,800 SU	9.8 SU	1,210 SU	--	--	1,320 SU	1,170 SU
Tetrachloroethene	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
Toluene	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	801 S
Trans-1,2-Dichloroethylene	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
trans-1,3-Dichloropropene	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
Trichloroethylene	ug/kg	NA	--	5,680 SU	11,900 SU	4.9 SU	606 SU	--	--	660 SU	587 SU
Vinyl acetate	ug/kg	NA	--	11,400 SU	23,800 SU	9.8 SU	1,210 SU	--	--	1,320 SU	1,170 SU
Vinyl chloride	ug/kg	NA	--	11,400 SU	23,800 SU	9.8 SU	1,210 SU	--	--	1,320 SU	1,170 SU
VOCs, Total	ug/kg	NA	--	210,670	506,100	0 U	24,590	--	--	15,832	22,241
Xylenes, Total	ug/kg	NA	--	14,600 S	44,800 S	9.8 SU	1,210 SU	--	--	1,320 SU	1,170 SU

Table 2-1

Summary of Chemicals Detected in Soil
 Union Carbide Corporation South Charleston Facility
 Remedial Approach Report

Analyte	Property									
	Units	Location>>		4146	4146	4146	4147	4147	4147	4148
		Sample Depth (m)>>	4146-SO01-062112	4146-SO02-062112	4146-SO03-062112	4147-SO01-062012	4147-SO02-062012	4147-SO03-062012	4148-SO01-062012	4148-SO02-062012
			6.5 - 7	18 - 18.5	24.5 - 25	6.5 - 7	6.5 - 7	16 - 16.5	30 - 30.5	13.5 - 14
	Minimum Screening Level	6/21/2012	6/21/2012	6/21/2012	6/21/2012	6/20/2012	6/20/2012	6/20/2012	6/20/2012	6/20/2012
Metal										
Total Organic Carbon by SW846-9060	MG/KG	NA								
VOC										
1,1,1-Trichloroethane	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
1,1,2,2-Tetrachloroethane	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
1,1,2-Trichloroethane	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
1,1-Dichloroethane	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
1,1-Dichloroethene	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
1,2,4-Trichlorobenzene	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	8310	1260	921000	382000
1,2-Dichlorobenzene	ug/kg	NA	1780	167	6.38 U	10.5	39900	7750	459000	168000
1,2-Dichloroethane	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
1,2-Dichloropropane	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
1,3-Dichlorobenzene	ug/kg	NA	550 U	13.8	6.38 U	5.82 U	702 U	730 U	5040	2130
1,4-Dichlorobenzene	ug/kg	NA	3020	207	6.38 U	13.9	49200	9660	701000	251000
1,4-Dioxane (p-Dioxane)	ug/kg	NA	187000 U	1790 U	2170 U	1980 U	239000 U	248000 U	205000 U	199000 U
2-Butanone	ug/kg	NA	2750 U	26.3 U	31.9 U	29.1 U	3510 U	3650 U	3020 U	2930 U
2-Hexanone	ug/kg	NA	1100 U	10.5 U	12.8 U	11.6 U	1400 U	1460 U	1210 U	1170 U
4-Methyl-2-pentanone	ug/kg	NA	1100 U	10.5 U	12.8 U	11.6 U	1400 U	1460 U	1210 U	1170 U
Acetone	ug/kg	NA	11000 U	105 U	128 U	116 U	14000 U	14600 U	12100 U	11700 U
Acrylonitrile	ug/kg	NA	11000 U	105 U	128 U	116 U	14000 U	14600 U	12100 U	11700 U
Benzene	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	4000	603 U	585 U
Bromodichloromethane	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
Bromoform	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
Bromomethane	ug/kg	NA	1100 U	10.5 U	12.8 U	11.6 U	1400 U	1460 U	1210 U	1170 U
Carbon disulfide	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
Carbon tetrachloride	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
Chlorobenzene	ug/kg	NA	550 U	66.7	6.38 U	5.82 U	2960	10600	31200	8410
Chloroethane	ug/kg	NA	1100 U	10.5 U	12.8 U	11.6 U	702 U	1460 U	1210 U	585 U
Chloroform	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	1400 U	730 U	603 U	1170 U
Chloromethane	ug/kg	NA	1100 U	10.5 U	12.8 U	11.6 U	702 U	1460 U	1210 U	2500 U
cis-1,2-Dichloroethylene	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	1400 U	730 U	603 U	585 U
cis-1,3-Dichloropropene	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
Dibromochloromethane	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
Ethylbenzene	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	1010	730 U	35200	8710
Methylene chloride	ug/kg	NA	550 U	10.5 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
Styrene	ug/kg	NA	550 U	5.27 U	6.38 U	11.6 U	1400 U	1460 U	11400	3510
tert-Butyl Methyl Ether	ug/kg	NA	1100 U	10.5 U	12.8 U	5.82 U	1090	730 U	1210 U	1170 U
Tetrachloroethene	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	1010	585 U
Toluene	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	1280	603 U	585 U
Trans-1,2-Dichloroethylene	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
trans-1,3-Dichloropropene	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
Trichloroethylene	ug/kg	NA	550 U	5.27 U	6.38 U	5.82 U	702 U	730 U	603 U	585 U
Vinyl acetate	ug/kg	NA	1100 U	10.5 U	12.8 U	11.6 U	1400 U	1460 U	1210 U	1170 U
Vinyl chloride	ug/kg	NA	1100 U	10.5 U	12.8 U	11.6 U	1400 U	1460 U	1210 U	5000 U
VOCs, Total	ug/kg	NA								
Xylenes, Total	ug/kg	NA	1100 U	10.5 U	12.8 U	11.6 U	1400 U	1460 U	29400	8820

Table 2-1
 Summary of Chemicals Detected in Soil
 Union Carbide Corporation South Charleston Facility
 Remedial Approach Report

Analyte	Property										
	Units	Location>>		4150	4150	4150	4153	4153	4153	4154	
		Sample ID>>	Sample Depth (m)>>	4150-SO01-062112	4150-SO02-062112	4150-SO03-062112	4153-SO01-061912	4153-SO02-061912	4153-SO03-061912	4154-SO01-061812	
			Sample Date>>	7 - 7.5	18.5 - 19	29.5 - 30	6 - 6.5	8 - 18.5	29.5 - 30	9 - 9.5	
		Minimum	Screening Level	6/21/2012	6/21/2012	6/21/2012	6/19/2012	6/19/2012	6/19/2012	6/18/2012	6/18/2012
Metal											
Total Organic Carbon by SW846-9060	MG/KG	NA									
VOC											
1,1,1-Trichloroethane	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
1,1,2,2-Tetrachloroethane	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
1,1,2-Trichloroethane	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
1,1-Dichloroethane	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
1,1-Dichloroethene	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
1,2,4-Trichlorobenzene	ug/kg	NA	10.5	4.89 U	5.44 U	5.26 U	4100	598 U	5.02 U	4.90 U	
1,2-Dichlorobenzene	ug/kg	NA	5.24 U	38.9	5.44 U	5.26 U	13900	4850	5.02 U	4.90 U	
1,2-Dichloroethane	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
1,2-Dichloropropane	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
1,3-Dichlorobenzene	ug/kg	NA	5.24 U	6.59	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
1,4-Dichlorobenzene	ug/kg	NA	5.79	87.6	5.44 U	5.26 U	22500	7410	5.02 U	5.91	
1,4-Dioxane (p-Dioxane)	ug/kg	NA	1780 U	1660 U	1850 U	1790 U	192000 U	203000 U	1710 U	1660 U	
2-Butanone	ug/kg	NA	26.2 U	24.5 U	27.2 U	26.3 U	2820 U	2990 U	25.1 U	24.5 U	
2-Hexanone	ug/kg	NA	10.5 U	9.78 U	10.9 U	10.5 U	1130 U	1200 U	10.0 U	9.79 U	
4-Methyl-2-pentanone	ug/kg	NA	10.5 U	9.78 U	10.9 U	10.5 U	1130 U	1200 U	10.0 U	9.79 U	
Acetone	ug/kg	NA	105 U	97.8 U	109 U	105 U	11300 U	12000 U	100 U	97.9 U	
Acrylonitrile	ug/kg	NA	105 U	97.8 U	109 U	105 U	11300 U	12000 U	100 U	97.9 U	
Benzene	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	3900	5.02 U	100	
Bromodichloromethane	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
Bromoform	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
Bromomethane	ug/kg	NA	10.5 U	9.78 U	10.9 U	10.5 U	1130 U	1200 U	10.0 U	9.79 U	
Carbon disulfide	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
Carbon tetrachloride	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
Chlorobenzene	ug/kg	NA	5.24 U	54.0	5.44 U	5.26 U	1310	4250	5.02 U	4.90 U	
Chloroethane	ug/kg	NA	10.5 U	9.78 U	10.9 U	10.5 U	1130 U	1200 U	10.0 U	9.79 U	
Chloroform	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
Chloromethane	ug/kg	NA	10.5 U	9.78 U	10.9 U	10.5 U	1130 U	1200 U	10.0 U	9.79 U	
cis-1,2-Dichloroethylene	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
cis-1,3-Dichloropropene	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
Dibromochloromethane	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
Ethylbenzene	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.82	
Methylene chloride	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
Styrene	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	1130 U	598 U	5.02 U	10.4	
tert-Butyl Methyl Ether	ug/kg	NA	10.5 U	9.78 U	10.9 U	10.5 U	565 U	1200 U	10.0 U	9.79 U	
Tetrachloroethene	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
Toluene	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	86.8	
Trans-1,2-Dichloroethylene	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
trans-1,3-Dichloropropene	ug/kg	NA	5.24 U	4.89 U	5.44 U	5.26 U	565 U	598 U	5.02 U	4.90 U	
Trichloroethylene	ug/kg	NA	5.24 U	4.89 U	7.56	5.26 U	565 U	598 U	5.02 U	4.90 U	
Vinyl acetate	ug/kg	NA	10.5 U	9.78 U	10.9 U	10.5 U	1130 U	1200 U	10.0 U	9.79 U	
Vinyl chloride	ug/kg	NA	10.5 U	9.78 U	10.9 U	10.5 U	1130 U	1200 U	10.0 U	9.79 U	
VOCs, Total	ug/kg	NA									
Xylenes, Total	ug/kg	NA	10.5 U	9.78 U	10.9 U	10.5 U	1130 U	1200 U	10.0 U	31.3	

Table 2-1

Summary of Chemicals Detected in Soil
 Union Carbide Corporation South Charleston Facility
 Remedial Approach Report

Analyte	Units	Minimum Screening Level	South of CIB area									
			Dow		Dow		Dow		Dow		Dow	
			Location>>	4112	4113	4113	4114	4114	4114	4114	4115	4115
			Sample ID>>	4112-SO01-072511	4113-SO02-082411	4113-SO01-082411	4114-SO01-072311	4114-SO02-072311	4114-SO03-072311	4114-SO04-072311	4115-SO01-090111	4115-SO02-090111
			Sample Depth (m)>>	29 - 29.5	29.5 - 30	9.5 - 10	20 - 20.5	33.5 - 34	44.5 - 45	52 - 53	22.5 - 23	29.5 - 30
			Sample Date>>	7/25/2011	8/24/2011	8/24/2011	7/23/2011	7/23/2011	7/23/2011	7/23/2011	9/1/2011	9/1/2011
Metal												
Total Organic Carbon by SW846-9060	MG/KG	NA	--	--	--	--	--	--	1,260 SU	1,190 SU	--	--
VOC												
1,1,1-Trichloroethane	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
1,1,2,2-Tetrachloroethane	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
1,1,2-Trichloroethane	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
1,1-Dichloroethane	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
1,1-Dichloroethene	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
1,2,4-Trichlorobenzene	ug/kg	NA	5.07 SU	2,200 S	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
1,2-Dichlorobenzene	ug/kg	NA	5.07 SU	4,440 S	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
1,2-Dichloroethane	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
1,2-Dichloropropane	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
1,3-Dichlorobenzene	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
1,4-Dichlorobenzene	ug/kg	NA	5.07 SU	1,950 S	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
1,4-Dioxane (p-Dioxane)	ug/kg	NA	1,720 SU	166,000 SU	1,600 SU	2,250 SU	2,420 SU	--	--	1,940 SU	1,980 SU	
2-Butanone	ug/kg	NA	25.3 SU	2,440 SU	23.6 SU	33.1 SU	35.6 SU	--	--	28.5 SU	29 SU	
2-Hexanone	ug/kg	NA	10.1 SU	975 SU	9.42 SU	13.2 SU	14.2 SU	--	--	11.4 SU	11.6 SU	
4-Methyl-2-pentanone	ug/kg	NA	10.1 SU	975 SU	9.42 SU	13.2 SU	14.2 SU	--	--	11.4 SU	11.6 SU	
Acetone	ug/kg	NA	101 SU	9,750 SU	94.2 SU	132 SU	142 SU	--	--	114 SU	116 SU	
Acrylonitrile	ug/kg	NA	101 SU	9,750 SU	94.2 SU	132 SU	142 SU	--	--	114 SU	116 SU	
Benzene	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
Bromodichloromethane	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
Bromoform	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
Bromomethane	ug/kg	NA	10.1 SU	975 SU	9.42 SU	13.2 SU	14.2 SU	--	--	11.4 SU	11.6 SU	
Carbon disulfide	ug/kg	NA	5.07 SU	487 SU	17.1 S	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
Carbon tetrachloride	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
Chlorobenzene	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
Chloroethane	ug/kg	NA	10.1 SU	975 SU	9.42 SU	13.2 SU	14.2 SU	--	--	11.4 SU	11.6 SU	
Chloroform	ug/kg	NA	5.54 S	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
Chloromethane	ug/kg	NA	10.1 SU	975 SU	9.42 SU	13.2 SU	14.2 SU	--	--	11.4 SU	11.6 SU	
cis-1,2-Dichloroethylene	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
cis-1,3-Dichloropropene	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
Dibromochloromethane	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
Ethylbenzene	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
Methylene chloride	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
Styrene	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
tert-Butyl Methyl Ether	ug/kg	NA	10.1 SU	975 SU	9.42 SU	13.2 SU	14.2 SU	--	--	11.4 SU	11.6 SU	
Tetrachloroethene	ug/kg	NA	157 S	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
Toluene	ug/kg	NA	5.69 S	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
Trans-1,2-Dichloroethylene	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
trans-1,3-Dichloropropene	ug/kg	NA	5.07 SU	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
Trichloroethylene	ug/kg	NA	10.6 S	487 SU	4.71 SU	6.61 SU	7.12 SU	--	--	5.69 SU	5.81 SU	
Vinyl acetate	ug/kg	NA	10.1 SU	975 SU	9.42 SU	13.2 SU	14.2 SU	--	--	11.4 SU	11.6 SU	
Vinyl chloride	ug/kg	NA	10.1 SU	975 SU	9.42 SU	13.2 SU	14.2 SU	--	--	11.4 SU	11.6 SU	
VOCs, Total	ug/kg	NA	178.83	8,590	17.1	0 U	0 U	--	--	0 U	0 U	
Xylenes, Total	ug/kg	NA	10.1 SU	975 SU	9.42 SU	13.2 SU	14.2 SU	--	--	11.4 SU	11.6 SU	

Table 2-1

Summary of Chemicals Detected in Soil
Union Carbide Corporation South Charleston Facility
Remedial Approach Report

Analyte	Units	Minimum Screening Level	OA Unit										
			Dow		Dow		Dow		Dow		Dow	Dow	
			Location>>	4116	Sample ID>>	4116	Sample Depth (m)>>	4116	Sample Date>>	4117	4117	4118	4118
			4116-SO01-082311	4116-SO02-082311	4116-SO03-082311	4117-SO02-072711	4117-SO01-072711	9.5 - 10	7/27/2011	19.5 - 20	8/22/2011	22.5 - 23	8/22/2011
Metal													
Total Organic Carbon by SW846-9060	MG/KG	NA	--	--	--	--	--	--	--	--	--	--	--
VOC													
1,1,1-Trichloroethane	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.15 SU	5.04 SU	
1,1,2,2-Tetrachloroethane	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.15 SU	5.04 SU	
1,1,2-Trichloroethane	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.15 SU	5.04 SU	
1,1-Dichloroethane	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.15 SU	5.04 SU	
1,1-Dichloroethene	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.15 SU	5.04 SU	
1,2,4-Trichlorobenzene	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.15 SU	5.04 SU	
1,2-Dichlorobenzene	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.15 SU	5.04 SU	
1,2-Dichloroethane	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.15 SU	5.04 SU	
1,2-Dichloropropane	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.15 SU	5.04 SU	
1,3-Dichlorobenzene	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.15 SU	5.04 SU	
1,4-Dichlorobenzene	ug/kg	NA	7.72 SU	4.59 SU	12.4 S	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.15 SU	5.04 SU	
1,4-Dioxane (p-Dioxane)	ug/kg	NA	2,620 SU	1,560 SU	122 SU	1,970 SU	1,740 SU	1,760 SU	1,820 SU	1,750 SU	1,710 SU		
2-Butanone	ug/kg	NA	38.6 SU	22.9 SU	29.5 SU	29 SU	25.6 SU	25.8 SU	26.8 SU	25.7 SU	25.2 SU		
2-Hexanone	ug/kg	NA	15.4 SU	9.18 SU	11.8 SU	11.6 SU	10.2 SU	10.3 SU	10.7 SU	10.3 SU	10.1 SU		
4-Methyl-2-pentanone	ug/kg	NA	15.4 SU	9.18 SU	11.8 SU	11.6 SU	10.2 SU	10.3 SU	10.7 SU	10.3 SU	10.1 SU		
Acetone	ug/kg	NA	154 SU	91.8 SU	118 SU	116 SU	102 SU	103 SU	107 SU	103 SU	101 SU		
Acrylonitrile	ug/kg	NA	154 SU	91.8 SU	118 SU	116 SU	102 SU	103 SU	107 SU	103 SU	101 SU		
Benzene	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	15.6 S	5.35 SU	5.15 SU	5.04 SU		
Bromodichloromethane	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.04 SU		
Bromoform	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.04 SU		
Bromomethane	ug/kg	NA	15.4 SU	9.18 SU	11.8 SU	11.6 SU	10.2 SU	10.3 SU	10.7 SU	10.3 SU	10.1 SU		
Carbon disulfide	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.04 SU		
Carbon tetrachloride	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.04 SU		
Chlorobenzene	ug/kg	NA	7.72 SU	4.59 SU	901 S	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.04 SU		
Chloroethane	ug/kg	NA	15.4 SU	9.18 SU	11.8 SU	11.6 SU	10.2 SU	10.3 SU	10.7 SU	10.3 SU	10.1 SU		
Chloroform	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.04 SU		
Chloromethane	ug/kg	NA	15.4 SU	9.18 SU	11.8 SU	11.6 SU	10.2 SU	10.3 SU	10.7 SU	10.3 SU	10.1 SU		
cis-1,2-Dichloroethylene	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 SU	5.04 SU		
cis-1,3-Dichloropropene	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 MU	5.04 SU		
Dibromochloromethane	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 MU	5.04 SU		
Ethylbenzene	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 MU	5.04 SU		
Methylene chloride	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 MU	5.04 SU		
Styrene	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 MU	5.04 SU		
tert-Butyl Methyl Ether	ug/kg	NA	15.4 SU	9.18 SU	11.8 SU	11.6 SU	10.2 SU	10.3 SU	10.7 SU	10.3 SU	10.1 SU		
Tetrachloroethene	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 MU	5.04 SU		
Toluene	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 MU	5.04 SU		
Trans-1,2-Dichloroethylene	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 MU	5.04 SU		
trans-1,3-Dichloropropene	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 MU	5.04 SU		
Trichloroethylene	ug/kg	NA	7.72 SU	4.59 SU	5.9 SU	5.81 SU	5.12 SU	5.17 SU	5.35 SU	5.15 MU	5.04 SU		
Vinyl acetate	ug/kg	NA	15.4 SU	9.18 SU	11.8 SU	11.6 SU	10.2 SU	10.3 SU	10.7 SU	10.3 SU	10.1 SU		
Vinyl chloride	ug/kg	NA	15.4 SU	9.18 SU	11.8 SU	11.6 SU	10.2 SU	10.3 SU	10.7 SU	10.3 SU	10.1 SU		
VOCs, Total	ug/kg	NA	0 U	0 U	913.4	0 U	0 U	15.6	0 U	0 U	0 U	0 U	
Xylenes, Total	ug/kg	NA	15.4 SU	9.18 SU	11.8 SU	11.6 SU	10.2 SU	10.3 SU	10.7 SU	10.3 SU	10.1 SU	10.1 SU	

Table 2-2

Summary of Chemicals Detected in Groundwater

Union Carbide Corporation South Charleston Facility

Remedial Approach Report

Analyte	Units	Property	Angled towards River			Angled Towards FMC			Angled Towards FMC		
			River		FMC	FMC	FMC	Dow	FMC	FMC	FMC
			Location>>	4100	4103	4103	4103	4104	4104	4104	4104
			Sample ID>>	4100-GW01-080911	4103-GW01-081311	4103-GW02-081311	4103-GW03-081311	4104-GW01-082511	4104-GW02-082511	4104-GW03-082511	4104-GW03-082511
VOC	Minimum Screening Level	Sample Depth (m)>>	111 - 116	54 - 59	64 - 69	84 - 89	20 - 25	44 - 49	64 - 69	217 S	3.67 S
			8/9/2011	8/13/2011	8/13/2011	8/13/2011	8/25/2011	8/25/2011	8/25/2011	42.7 S	2.2 S
1,1,1-Trichloroethane	ug/L	NA	1 SU	1 SU	1 SU	1 SU	10 SU	1 SU	1 SU	1 SU	1 SU
1,1,2,2-Tetrachloroethane	ug/L	NA	1 SU	1 SU	1.45 S	1 SU	10 SU	1 SU	1 SU	1 SU	3.67 S
1,1,2-Trichloroethane	ug/L	NA	1 SU	1 SU	6.12 S	2.02 S	10 SU	1 SU	1 SU	1 SU	2.2 S
1,1-Dichloroethane	ug/L	NA	1 SU	1 SU	1 SU	1 SU	10 SU	1 SU	1 SU	1 SU	1 SU
1,1-Dichloroethene	ug/L	NA	1 SU	1 SU	1 SU	1 SU	10 SU	1 SU	1 SU	1 SU	1.14 S
1,2,4-Trichlorobenzene	ug/L	NA	8.47 S	112 S	15.9 S	9.03 S	14,000 S	574 S	574 S	217 S	217 S
1,2-Dichlorobenzene	ug/L	NA	11.3 S	31.4 S	10.7 S	4.03 S	8,140 S	212 S	212 S	64.4 S	64.4 S
1,2-Dichloroethane	ug/L	NA	1.21 S	3.79 S	17.2 S	20.3 S	10 SU	1 SU	1 SU	1 SU	42.7 S
1,2-Dichloropropane	ug/L	NA	1 SU	1 SU	10.3 S	5.68 S	10 SU	1 SU	1 SU	1 SU	11.6 S
1,3-Dichlorobenzene	ug/L	NA	3.79 S	3.15 S	1 SU	1 SU	144 S	4.97 S	4.97 S	1.4 S	1.4 S
1,4-Dichlorobenzene	ug/L	15	24.2 S	66.3 S	21 S	7.85 S	18,700 S	471 S	471 S	147 S	147 S
1,4-Dioxane (p-Dioxane)	ug/L	NA	100 SU	100 SU	100 SU	100 SU	1,000 SU	100 SU	100 SU	100 SU	100 SU
2-Butanone	ug/L	NA	10 SU	10 SU	10 SU	10 SU	100 SU	10 SU	10 SU	10 SU	10 SU
2-Hexanone	ug/L	NA	5 SU	5 SU	5 SU	5 SU	50 SU	5 SU	5 SU	5 SU	5 SU
4-Methyl-2-pentanone	ug/L	NA	5 SU	5 SU	5 SU	5 SU	50 SU	5 SU	5 SU	5 SU	5 SU
Acetone	ug/L	NA	25 SU	25 SU	25 SU	25 SU	250 SU	25 SU	25 SU	25 SU	25 SU
Acrylonitrile	ug/L	NA	10 SU	10 SU	10 SU	10 SU	100 SU	10 SU	10 SU	10 SU	10 SU
Benzene	ug/L	130	1 SU	26.7 S	3.01 S	1.51 S	12.7 S	1.26 S	1.26 S	8.48 S	8.48 S
Bromodichloromethane	ug/L	NA	15.4 S	11.7 S	13.9 S	12.1 S	10 SU	9.78 S	9.78 S	1.62 S	1.62 S
Bromoform	ug/L	NA	1 SU	1 SU	1 SU	1 SU	10 SU	1 SU	1 SU	1 SU	1 SU
Bromomethane	ug/L	NA	1 SU	1 SU	1 SU	1 SU	10 SU	1 SU	1 SU	1 SU	1 SU
Carbon disulfide	ug/L	NA	1 SU	1 SU	1 SU	1 SU	10 SU	1 SU	1 SU	1 SU	1 SU
Carbon tetrachloride	ug/L	NA	1 SU	1.23 S	2.42 S	1 SU	10 SU	1 SU	1 SU	1 SU	17.2 S
Chlorobenzene	ug/L	64	5.03 S	48.5 S	7.78 S	2.2 S	55.4 S	3.13 S	3.13 S	6.56 S	6.56 S
Chloroethane	ug/L	NA	1 SU	1 SU	1 SU	1 SU	10 SU	1 SU	1 SU	1 SU	1 SU
Chloroform	ug/L	NA	30.2 S	28.7 S	38.9 S	35.1 S	17.4 S	19.3 S	19.3 S	58.3 S	58.3 S
Chloromethane	ug/L	NA	1 SU	1 SU	1 SU	1 SU	10 SU	1 SU	1 SU	1 SU	1 SU
cis-1,2-Dichloroethylene	ug/L	NA	1.08 S	1 SU	1.32 S	9.59 S	10 SU	1 SU	1 SU	1 SU	1.41 S
cis-1,3-Dichloropropene	ug/L	NA	1 SU	1 SU	1 SU	1 SU	10 SU	1 SU	1 SU	1 SU	1 SU
Dibromochloromethane	ug/L	NA	5.99 S	4.01 S	5.34 S	4.42 S	10 SU	3.53 S	3.53 S	1 SU	1 SU
Ethylbenzene	ug/L	NA	1 SU	1 SU	1 SU	1 SU	10 SU	1 SU	1 SU	1 SU	1 SU
Methylene chloride	ug/L	NA	5 SU	5 SU	5 SU	5 SU	50 SU	5 SU	5 SU	5 SU	5 SU
Styrene	ug/L	NA	1 SU	1 SU	1 SU	1 SU	10 SU	1 SU	1 SU	1 SU	1 SU
tert-Butyl Methyl Ether	ug/L	NA	5 SU	5 SU	5 SU	5 SU	50 SU	5 SU	5 SU	5 SU	5 SU
Tetrachloroethene	ug/L	NA	1 SU	1.52 S	14.5 S	7.93 S	10 SU	1 SU	1 SU	17.3 S	17.3 S
Toluene	ug/L	NA	1 SU	1.1 S	1 SU	1 SU	24.8 S	1 SU	1 SU	1 SU	1.26 S
Trans-1,2-Dichloroethylene	ug/L	NA	1 SU	1 SU	1 SU	1 SU	10 SU	1 SU	1 SU	1 SU	1 SU
trans-1,3-Dichloropropene	ug/L	NA	1 SU	1 SU	1 SU	1 SU	10 SU	1 SU	1 SU	1 SU	1 SU
Trichloroethylene	ug/L	47	8.46 S	14.3 S	166 S	153 S	10 SU	1 SU	1 SU	291 S	291 S
Vinyl acetate	ug/L	NA	10 SU	10 SU	10 SU	10 SU	100 SU	10 SU	10 SU	10 SU	10 SU
Vinyl chloride	ug/L	NA	1 SU	1 SU	1 SU	1 SU	10 SU	1 SU	1 SU	1 SU	1 SU
VOCs, Total	ug/L	NA	115.13	354.4	335.84	275.83	41,094.30	1,298.97	1,298.97	894.24	894.24
Xylenes, Total	ug/L	NA	5 SU	5 SU	5 SU	5 SU	50 SU	5 SU	5 SU	5 SU	5 SU

Table 2-2

Summary of Chemicals Detected in Groundwater
 Union Carbide Corporation South Charleston Facility
 Remedial Approach Report

Analyte	Units	Property	ACM Area							
			FMC	Dow						
			Location>>	4104	4105	4106	4107	4108	4109	4110
			Sample ID>>	4104-GW01-082611	4105-GW01-072211	4106-GW01-101711	4107-GW01-102611	4108-GW01-102411	4109-GW01-101911	4110-GW01-102011
			Sample Depth (m)>>	89 - 94	35 - 40	40 - 44	50 - 54	51 - 55	36 - 40	51 - 55
			Sample Date>>	8/26/2011	7/22/2011	10/17/2011	10/26/2011	10/24/2011	10/19/2011	10/20/2011
			Minimum Screening Level							
VOC										
1,1,1-Trichloroethane	ug/L	NA	5 SU	1 SU	10 SU	1 SU	1 SU	2 SU	2.5 SU	
1,1,2,2-Tetrachloroethane	ug/L	NA	5 SU	1.01 S	15 S	1 SU	1 SU	8.98 S	2.5 SU	
1,1,2-Trichloroethane	ug/L	NA	5 SU	9.43 S	30.4 S	1 SU	1 SU	15.4 S	2.5 SU	
1,1-Dichloroethane	ug/L	NA	5 SU	1 SU	10 SU	1 SU	1 SU	2 SU	2.5 SU	
1,1-Dichloroethene	ug/L	NA	5 SU	10.1 S	27.1 S	1 SU	1 SU	14.9 S	2.5 SU	
1,2,4-Trichlorobenzene	ug/L	NA	20 S	61.3 S	64.5 S	3.26 S	1 SU	11.5 S	154 S	
1,2-Dichlorobenzene	ug/L	NA	5 SU	50.4 S	145 S	4.14 S	10 S	24.2 S	342 S	
1,2-Dichloroethane	ug/L	NA	28.4 S	31.4 S	10 SU	1 SU	2.99 S	13.6 S	9.2 S	
1,2-Dichloropropane	ug/L	NA	5 SU	24.8 S	34.7 S	1 SU	2.94 S	16.3 S	3.55 S	
1,3-Dichlorobenzene	ug/L	NA	5 SU	1 SU	10 SU	1 SU	1 SU	2 SU	2.5 SU	
1,4-Dichlorobenzene	ug/L	15	8.91 S	95.7 S	227 S	3.99 S	12.8 S	57.3 S	370 S	
1,4-Dioxane (p-Dioxane)	ug/L	NA	500 SU	100 SU	1,000 SU	100 SU	100 SU	200 SU	250 SU	
2-Butanone	ug/L	NA	50 SU	10 SU	100 SU	10 SU	10 SU	20 SU	25 SU	
2-Hexanone	ug/L	NA	25 SU	5 SU	50 SU	5 SU	5 SU	10 SU	12.5 SU	
4-Methyl-2-pentanone	ug/L	NA	25 SU	5 SU	50 SU	5 SU	5 SU	10 SU	12.5 SU	
Acetone	ug/L	NA	125 SU	25 SU	250 SU	25 SU	25 SU	50 SU	62.5 SU	
Acrylonitrile	ug/L	NA	50 SU	10 SU	100 SU	10 SU	10 SU	20 SU	25 SU	
Benzene	ug/L	130	5 SU	250 S	12.9 S	36.2 S	21.9 S	185 S	45.1 S	
Bromodichloromethane	ug/L	NA	5 SU	1 SU	10 SU	1 SU	1 SU	2 SU	2.5 SU	
Bromoform	ug/L	NA	5 SU	1 SU	10 SU	1 SU	1 SU	2 SU	2.5 SU	
Bromomethane	ug/L	NA	5 SU	1 SU	10 SU	1 SU	1 SU	2 SU	2.5 SU	
Carbon disulfide	ug/L	NA	5 SU	1 SU	10 SU	2 S	1 SU	2 SU	2.5 SU	
Carbon tetrachloride	ug/L	NA	5 SU	6.42 S	10 SU	1 SU	1 SU	61.4 S	2.5 SU	
Chlorobenzene	ug/L	64	5 SU	291 S	94.6 S	4.26 S	480 S	57.5 S	95.8 S	
Chloroethane	ug/L	NA	5 SU	1 SU	10 SU	1 SU	1 SU	2 SU	2.5 SU	
Chloroform	ug/L	NA	7.54 S	29.7 S	10 SU	1 SU	1.19 S	47.5 S	21.8 S	
Chloromethane	ug/L	NA	5 SU	1 SU	10 SU	1 SU	1 SU	2 SU	2.5 SU	
cis-1,2-Dichloroethylene	ug/L	NA	5 SU	526 S	1,110 S	4.45 S	4.16 S	58.7 S	29.7 S	
cis-1,3-Dichloropropene	ug/L	NA	5 SU	1 SU	10 SU	1 SU	1 SU	2 SU	2.5 SU	
Dibromochloromethane	ug/L	NA	5 SU	1 SU	10 SU	1 SU	1 SU	2 SU	2.5 SU	
Ethylbenzene	ug/L	NA	5 SU	1 SU	32.6 S	2.2 S	1 SU	10.6 S	2.5 SU	
Methylene chloride	ug/L	NA	25 SU	5 SU	50 SU	5 SU	5 SU	10 SU	12.5 SU	
Styrene	ug/L	NA	5 SU	1 SU	20.9 S	2.34 S	1 SU	2 SU	2.5 SU	
tert-Butyl Methyl Ether	ug/L	NA	25 SU	5 SU	50 SU	5 SU	5 SU	10 SU	12.5 SU	
Tetrachloroethene	ug/L	NA	6.64 S	35.4 S	23.7 S	1 SU	2.38 S	10.7 S	2.5 SU	
Toluene	ug/L	NA	5 SU	14.1 S	37.3 S	2.39 S	1 SU	3.23 S	3.4 S	
Trans-1,2-Dichloroethylene	ug/L	NA	5 SU	9.32 S	26.3 S	1 SU	1 SU	3.68 S	2.5 SU	
trans-1,3-Dichloropropene	ug/L	NA	5 SU	1 SU	10 SU	1 SU	1 SU	2 SU	2.5 SU	
Trichloroethylene	ug/L	47	138 S	906 S	378 S	1 SU	14.3 S	215 S	11.3 S	
Vinyl acetate	ug/L	NA	50 SU	10 SU	100 SU	10 SU	10 SU	20 SU	25 SU	
Vinyl chloride	ug/L	NA	7.9 S	6.29 S	10 SU	1 SU	1.86 S	6.82 S	5.38 S	
VOCs, Total	ug/L	NA	217.39	2,358.37	2,280	65.23	555.96	822.31	1,091.23	
Xylenes, Total	ug/L	NA	25 SU	5 SU	50 SU	5 SU	5 SU	10 SU	12.5 SU	

Table 2-2

Summary of Chemicals Detected in Groundwater

Union Carbide Corporation South Charleston Facility

Remedial Approach Report

Analyte	Units	Property Location>> Sample ID>> Sample Depth (m)>> Sample Date>>	Dow	Dow	Dow	Dow	Dow	Dow	South of CIB Area
			4111	4120	4147	4148	4148	4112	4113
			46 - 50	49 - 53	36.5-40.5	30 - 34	46 - 50	45 - 50	55 - 60
			10/20/2011	10/25/2011	6/22/2012	6/22/2012	6/22/2012	7/25/2011	8/24/2011
VOC		Minimum Screening Level							
1,1,1-Trichloroethane	ug/L	NA	1 SU	1 SU	2 U	1 U	1 U	1 SU	1 SU
1,1,2,2-Tetrachloroethane	ug/L	NA	1 SU	1 SU	3.18	1 U	1 U	1 SU	1 SU
1,1,2-Trichloroethane	ug/L	NA	1 SU	1 SU	4.45	2.28	1 U	1 SU	1 SU
1,1-Dichloroethane	ug/L	NA	1 SU	1 SU	2 U	1 U	1 U	1 SU	1 SU
1,1-Dichloroethene	ug/L	NA	1 SU	2.19 S	2 U	1 U	5.07	1 SU	1 SU
1,2,4-Trichlorobenzene	ug/L	NA	1 SU	2.82 S	2 U	2930	81.5	1 SU	1 SU
1,2-Dichlorobenzene	ug/L	NA	1.37 S	3.25 S	4.45	7560	202	1 SU	1.2 S
1,2-Dichloroethane	ug/L	NA	1 SU	3.42 S	33.7	1 U	65.7	1.74 S	2.59 S
1,2-Dichloropropane	ug/L	NA	1 SU	2.81 S	13.2	26	16.1	5.34 S	1.78 S
1,3-Dichlorobenzene	ug/L	NA	1 SU	1 SU	2 U	16.6	1.31	1 SU	1 SU
1,4-Dichlorobenzene	ug/L	15	1.46 S	5.84 S	9.95	38500	294	1 SU	1.08 S
1,4-Dioxane (p-Dioxane)	ug/L	NA	100 SU	100 SU	200 U	100 U	100 U	100 SU	100 SU
2-Butanone	ug/L	NA	10 SU	10 SU	20 U	10.5	10 U	10 SU	10 SU
2-Hexanone	ug/L	NA	5 SU	5 SU	10 U	5 U	5 U	5 SU	5 SU
4-Methyl-2-pentanone	ug/L	NA	5 SU	5 SU	10 U	5 U	5 U	5 SU	5 SU
Acetone	ug/L	NA	25 SU	31.7 S	50 U	188	40	25 SU	25 SU
Acrylonitrile	ug/L	NA	10 SU	10 SU	20 U	10 U	10 U	10 SU	10 SU
Benzene	ug/L	130	73.8 S	22.6 S	13.9	3960	32.6	10.7 S	1.98 S
Bromodichloromethane	ug/L	NA	1 SU	1 SU	2 U	1 U	1 U	1 SU	1.2 S
Bromoform	ug/L	NA	1 SU	1 SU	2 U	1 U	1 U	1 SU	1 SU
Bromomethane	ug/L	NA	1 SU	1 SU	2 U	1 U	1 U	1 SU	1 SU
Carbon disulfide	ug/L	NA	1 SU	1 SU	2 U	1 U	1 U	1 SU	1 SU
Carbon tetrachloride	ug/L	NA	1 SU	1 SU	3.10	1 U	1 U	1 SU	1 SU
Chlorobenzene	ug/L	64	15.9 S	12.2 S	42.3	1 U	114	80.7 S	73.1 S
Chloroethane	ug/L	NA	1 SU	1 SU	2 U	1 U	1 U	1 SU	1 SU
Chloroform	ug/L	NA	1 SU	3.63 S	14.7	17.3	99.7	56.2 S	7.48 S
Chloromethane	ug/L	NA	1 SU	1 SU	2 U	1 U	1 U	1 SU	1 SU
cis-1,2-Dichloroethylene	ug/L	NA	1.14 S	32.6 S	324	6.48	18.7	2.32 S	1 SU
cis-1,3-Dichloropropene	ug/L	NA	1 SU	1 SU	2 U	1 U	1 U	1 SU	1 SU
Dibromochloromethane	ug/L	NA	1 SU	1 SU	2 U			1 SU	1 SU
Ethylbenzene	ug/L	NA	1 SU	1 SU	2 U	457	23.1	1 SU	1 SU
Methylene chloride	ug/L	NA	5 SU	5 SU	10 U	5 U	5 U	5 SU	5 SU
Styrene	ug/L	NA	1 SU	1 SU	2 U	45.5	39.2	1 SU	1 SU
tert-Butyl Methyl Ether	ug/L	NA	5 SU	5 SU	10 U	5 U	5 U	5 SU	5 SU
Tetrachloroethene	ug/L	NA	1 SU	1 SU	5.9	3.88	5 U	42.5 S	1 SU
Toluene	ug/L	NA	1 SU	1 SU	2 U	1330	15.4	2.52 S	1 SU
Trans-1,2-Dichloroethylene	ug/L	NA	1 SU	1.31 S	8.12	1 U	1 U	1 SU	1 SU
trans-1,3-Dichloropropene	ug/L	NA	1 SU	1 SU	2 U	1 U	1 U	1 SU	1 SU
Trichloroethylene	ug/L	47	1 SU	19.7 S	158	8.2	108	5.21 S	1 SU
Vinyl acetate	ug/L	NA	10 SU	10 SU	20 U	10 U	10 U	10 SU	10 SU
Vinyl chloride	ug/L	NA	1.56 S	4.83 S	2 U	4.7	9.22	1 SU	1 SU
VOCs, Total	ug/L	NA	95.23	148.9				207.23	90.41
Xylenes, Total	ug/L	NA	5 SU	5 SU	10 U	243	43.2	5 SU	5 SU

Table 2-2

Summary of Chemicals Detected in Groundwater

Union Carbide Corporation South Charleston Facility

Remedial Approach Report

Analyte	Units	Property Location>> Sample ID>> Sample Depth (m)>> Sample Date>>	OA Unit							
			Dow	Dow	Dow	Dow	Dow	Dow	Dow	Dow
			4114	4115	4116	4116	4117	4118	4119	
VOC										
1,1,1-Trichloroethane	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
1,1,2,2-Tetrachloroethane	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
1,1,2-Trichloroethane	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
1,1-Dichloroethane	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
1,1-Dichloroethene	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
1,2,4-Trichlorobenzene	ug/L	NA	1.99 S	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
1,2-Dichlorobenzene	ug/L	NA	8.31 S	10 SU	1 SU	1 SU	21.8 S	10 SU	2 SU	
1,2-Dichloroethane	ug/L	NA	96.9 S	10 SU	1 SU	1.86 S	5.46 S	10 SU	2.76 S	
1,2-Dichloropropane	ug/L	NA	6.21 S	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
1,3-Dichlorobenzene	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
1,4-Dichlorobenzene	ug/L	15	9.81 S	10 SU	1 SU	1 SU	13.9 S	24.5 S	2 SU	
1,4-Dioxane (p-Dioxane)	ug/L	NA	100 SU	1,000 SU	184 S	100 SU	265 S	4,570 S	200 SU	
2-Butanone	ug/L	NA	10 SU	100 SU	10 SU	10 SU	10 SU	100 SU	20 SU	
2-Hexanone	ug/L	NA	5 SU	50 SU	5 SU	5 SU	5 SU	50 SU	10 SU	
4-Methyl-2-pentanone	ug/L	NA	5 SU	50 SU	5 SU	5 SU	5 SU	50 SU	10 SU	
Acetone	ug/L	NA	25 SU	250 SU	25 SU	25 SU	25 SU	250 SU	50 SU	
Acrylonitrile	ug/L	NA	10 SU	100 SU	10 SU	10 SU	10 SU	100 SU	20 SU	
Benzene	ug/L	130	11.5 S	10 SU	4.16 S	1.51 S	5.33 S	1,550 S	5.63 S	
Bromodichlormethane	ug/L	NA	1 SU	10 SU	1 SU	1.92 S	1 SU	10 SU	2 SU	
Bromoform	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
Bromomethane	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
Carbon disulfide	ug/L	NA	1.11 S	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
Carbon tetrachloride	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
Chlorobenzene	ug/L	64	206 S	10 SU	38.9 S	12.1 S	187 S	507 S	147 S	
Chloroethane	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	23.8 S	2 SU	
Chloroform	ug/L	NA	1.16 S	10 SU	1 SU	20.4 S	1 SU	10 SU	3.69 S	
Chloromethane	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
cis-1,2-Dichloroethylene	ug/L	NA	9.43 S	10 SU	1 SU	1 SU	9.65 S	10 SU	5.79 S	
cis-1,3-Dichloropropene	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
Dibromochloromethane	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
Ethylbenzene	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	307 S	2 SU	
Methylene chloride	ug/L	NA	5 SU	50 SU	5 SU	5 SU	5 SU	50 SU	10 SU	
Styrene	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
tert-Butyl Methyl Ether	ug/L	NA	5 SU	50 SU	5 SU	5 SU	5 SU	50 SU	10 SU	
Tetrachloroethene	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
Toluene	ug/L	NA	2.26 S	10 SU	1 SU	1 SU	1 SU	14.6 S	2 SU	
Trans-1,2-Dichloroethylene	ug/L	NA	1.01 S	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
trans-1,3-Dichloropropene	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
Trichloroethylene	ug/L	47	4.14 S	10 SU	1 SU	1 SU	1 SU	10 SU	2 SU	
Vinyl acetate	ug/L	NA	10 SU	100 SU	10 SU	10 SU	10 SU	100 SU	20 SU	
Vinyl chloride	ug/L	NA	1 SU	10 SU	1 SU	1 SU	1 SU	10 SU	20.4 S	
VOCs, Total	ug/L	NA	359.83	0 U	227.06	37.79	509.33	7,126.90	185.27	
Xylenes, Total	ug/L	NA	5 SU	50 SU	5 SU	5 SU	5 SU	130 S	10 SU	

Table 2-2

Summary of Chemicals Detected in Groundwater
Union Carbide Corporation South Charleston Facility
Remedial Approach Report

Analyte	Units	Property	Dow	Dow	Dow	
			Location>>	4189	4191	4192
			Sample ID>>	4189-GW01-041013	4191-GW01-041013	4192-GW01-040813
			Sample Depth (m)>>	46-50	46-50	46-50
			Sample Date>>	4/10/2013	4/10/2013	4/8/2013
		Minimum Screening Level				
VOC						
1,1,1-Trichloroethane	ug/L	NA	100 SU	1 SU	1 SU	
1,1,2,2-Tetrachloroethane	ug/L	NA	100 SU	1 SU	1 SU	
1,1,2-Trichloroethane	ug/L	NA	100 SU	1 SU	1.48 S	
1,1-Dichloroethane	ug/L	NA	100 SU	1 SU	1 SU	
1,1-Dichloroethene	ug/L	NA	100 SU	1.42 S	2.88 S	
1,2,4-Trichlorobenzene	ug/L	NA	100 SU	63.7 S	33.5 S	
1,2-Dichlorobenzene	ug/L	NA	100 SU	25.1 S	166 S	
1,2-Dichloroethane	ug/L	NA	100 SU	22.5 S	42.1 S	
1,2-Dichloropropane	ug/L	NA	100 SU	4.27 S	8.41 S	
1,3-Dichlorobenzene	ug/L	NA	100 SU	1 SU	1 SU	
1,4-Dichlorobenzene	ug/L	15	100 SU	36.9 S	190 S	
1,4-Dioxane (p-Dioxane)	ug/L	NA	10000 SU	100 SU	100 SU	
2-Butanone	ug/L	NA	1000 SU	10 U	10 SU	
2-Hexanone	ug/L	NA	500 SU	5 SU	5 SU	
4-Methyl-2-pentanone	ug/L	NA	500 SU	5 SU	5 SU	
Acetone	ug/L	NA	2500 SU	25 SU	25 SU	
Acrylonitrile	ug/L	NA	1000 SU	10 SU	10 SU	
Benzene	ug/L	130	100 SU	25.9 S	121 S	
Bromodichloromethane	ug/L	NA	100 SU	1 SU	1 SU	
Bromoform	ug/L	NA	100 SU	1 SU	1 SU	
Bromomethane	ug/L	NA	100 SU	1 SU	1 SU	
Carbon disulfide	ug/L	NA	100 SU	1 SU	1 SU	
Carbon tetrachloride	ug/L	NA	100 SU	1 SU	1 SU	
Chlorobenzene	ug/L	64	100 SU	24.0 S	104 S	
Chloroethane	ug/L	NA	100 SU	1 SU	1 SU	
Chloroform	ug/L	NA	100 SU	20.6 S	119 S	
Chloromethane	ug/L	NA	100 SU	1 SU	1 SU	
cis-1,2-Dichloroethylene	ug/L	NA	342 S	27.4 S	34.6 S	
cis-1,3-Dichloropropene	ug/L	NA	100 SU	1 SU	1 SU	
Dibromochloromethane	ug/L	NA	NS	NS	NS	
Ethylbenzene	ug/L	NA	100 SU	1 SU	1 SU	
Methylene chloride	ug/L	NA	500 SU	5 SU	5 SU	
Styrene	ug/L	NA	100 SU	1 SU	1 SU	
tert-Butyl Methyl Ether	ug/L	NA	500 SU	5 SU	5 SU	
Tetrachloroethene	ug/L	NA	100 SU	1.36 S	1 SU	
Toluene	ug/L	NA	100 SU	4.35 S	2.18 S	
Trans-1,2-Dichloroethylene	ug/L	NA	100 SU	1 SU	1.54 S	
trans-1,3-Dichloropropene	ug/L	NA	100 SU	1 SU	1 SU	
Trichloroethylene	ug/L	47	100 SU	11.6 S	16.6 S	
Vinyl acetate	ug/L	NA	1000 SU	10 SU	10 SU	
Vinyl chloride	ug/L	NA	100 SU	5.92 S	20.1 S	
VOCs, Total	ug/L	NA	NS	NS	NS	
Xylenes, Total	ug/L	NA	500 SU	5 SU	5 SU	

TABLE 4-1
 Chlorobenzene Area Technology Screening
Union Carbide Corporation South Charleston Facility
Remedial Approach Report

REMEDIAL OBJECTIVE – Clean up soil and groundwater to levels that would result in acceptable groundwater discharge to the Kanawha River (Section 3.1).

Remedial Technology	Process Options	Descriptions	Effectiveness	Implementability	Relative Cost Range
Administrative Controls	Deed restrictions/ Environmental covenant	Restricts access to contaminated media through restrictive covenants on property deeds. Notices to prevent installation of wells in area exceeding U.S. Environmental Protection Agency (USEPA) maximum contaminant levels (MCLs).	Not applicable Not effective in restricting migration of constituents of potential concern (COPCs) in groundwater to pore water.	High Requires working with facility stakeholders.	Low Periodic inspection of the use restrictions would be required, thus incurring minimal operation and maintenance (O&M) costs.
Hydraulic Containment	Extraction wells to pump and treat (P&T) groundwater East and West Areas	Install extraction wells to create capture zones within and hydraulically downgradient of source areas. Depending on accessibility, extraction wells may be installed vertically or directionally drilled. Wells and pumps may be screened at different depth intervals to improve effectiveness. Contaminated groundwater may need to be treated prior to discharging to the facility process sewer. Hydraulic monitoring system will be required to demonstrate effectiveness. Typically accomplished using a series of monitoring wells that demonstrates a gradient reversal (e.g., inland flow from the river).	Soil: Not applicable Groundwater: High If adequate capture zones are established, pumping will provide hydraulic control. Does not treat contamination in vadose zone.	Medium Extraction wells can be installed; however, accessibility to some areas may be limited by existing facilities. For the eastern area, the supporting infrastructure and utilities will need to be run within the Oxide Adducts (OA) Unit.	High High capital cost and high O&M cost. Groundwater modeling will be required to evaluate capture zone of extraction wells. In addition to installing extraction wells, a treatment system may need to be installed to pre-treat extracted groundwater prior to discharge to the process sewer. Requires weekly operation and maintenance.
Remediation Technologies	Pneumatic and hydraulic fracturing West Area Only	Pneumatically or hydraulically fracture clayey soil in the vadose zone to improve vapor capture or substrate distribution.	Medium Effective in low-permeability soils. Fracturing is applicable with a variety of in-situ remedial technologies; however, fracturing alone will not reduce concentrations of contaminants.	Medium Implementability is subject to the presence of structures and possible underground utilities. There is a potential to open new pathways leading to the unwanted spread of contaminants.	Medium The cost (including equipment rental, operation, and monitoring) is small compared to the benefits of enhanced remediation and the reduced number of wells needed to complete remediation.
	Air sparge/soil vapor extraction (AS/SVE) via vertical and angled wells East and West Areas	Install a vertical and angled well AS/SVE network within zones of impacted groundwater and soil, respectively. The vertical AS wells will be installed within areas where impacts to	Soil: Low without soil fracturing; medium with soil fracturing. Groundwater: Medium to high. AS enhances oxygenation in the subsurface. High concentrations of	Medium to High Directionally drilled wells can be installed below existing facility structures and utilities. SVE implementability limited (unless	High High capital cost and moderate O&M cost. Process equipment, vapor treatment equipment, and

		<p>groundwater are present in order to strip contamination. Angled wells will be installed where access is limited (such as near the transmission tower).</p> <p>Install vertical or angled SVE wells within vadose zone materials to remove contamination and install vent wells to alleviate pressure build from AS activities. SVE wells can be installed within fractured or non-fractured material. Angled SVE wells can also be installed where access is limited (such as near the transmission tower).</p>	<p>constituents of potential concern (COPCs) are difficult to reduce to target levels using in-situ injection. Effectiveness to sparge across the entire thickness of the saturated zone may be limited by the presence of low-permeability layers within the saturated zone. Multiple depths of vertical AS wells may be required to adequately reduce COPC concentrations to pore water cleanup levels.</p> <p>Except in localized areas where SVE wells are installed within permeable vadose zone, remedial technology will not treat vadose zone soil without fracturing</p>	<p>fracturing occurs) to accessible areas with sufficient thickness of permeable vadose. Limited ability to install vent wells within OA unit.</p> <p>Multiple process equipment and vapor treatment equipment skids may be required if SVE well fields are scattered across the target control area.</p>	groundwater treatment equipment required. Requires weekly O&M.
	In-Situ Chemical Oxidation (ISCO) West Area Only	<p>A chemical oxidant would be injected into the subsurface via injection wells and/or direct push so that there is direct contact between the oxidant and the constituents of concern (COCs). The injection points would be installed to create treatment zones where feasible, within the COC plumes. Oxidants that are applicable for the site-specific COCs are catalyzed hydrogen peroxide, heat-, alkaline-, and peroxide-activated persulfate, and ozone/perozone.</p> <p>Pilot-scale studies would be necessary to identify suitable oxidant, assess site-specific feasibility, and obtain necessary design data.</p>	<p>Medium to High</p> <p>Chemical oxidation has been shown to be effective for degrading chlorinated benzenes in dissolved phase. Effectiveness may be limited due to presence of COPCs entrained/bound in low permeability soils. Soil fracturing would enhance secondary permeability of these soils.</p> <p>Careful ISCO approach selection is necessary for sites with NAPL and contaminants in lower-permeability soil. For these situations, activated (heat, alkaline) persulfate can be more effective.</p> <p>If oxidation-sensitive metals are present in soil (e.g., chromium [Cr]), they can be temporarily solubilized with implementation of ISCO. However, literature indicates the effects are temporary and conditions will return to background levels after oxidation is complete.</p>	<p>Medium to High</p> <p>Implementability may be limited due to site constraints and the ability to deliver chemical reagents into low permeability soils in the vadose zone.</p> <p>May result in off-gas production (peroxide) and/or daylighting of chemical agent, but it can be controlled through low-pressure injection and use of non-off-gassing oxidant selection.</p>	<p>Medium to High</p> <p>Multiple injections of oxidant will be required to achieve cleanup levels.</p> <p>Frequent groundwater monitoring will be required to track the change in concentrations after ISCO.</p>
	Steam Enhanced Extraction (SEE)	<p>SEE achieves onsite separation and treatment of COPCs through steam injection through wells and extraction of hot fluids. The injected steam is used to heat the subsurface to target treatment temperatures, typically the boiling point of the COPC.</p>	<p>Soil: Low</p> <p>Groundwater: Medium to High</p> <p>SEE is effective for large and deep sites with significant groundwater flow. The SEE technology allows for high extraction of fluids and displaces large amounts of groundwater towards the extraction wells. As a result, less water</p>	<p>Medium to High</p> <p>Generally can be implemented in the West Area. Implementability may be limited in some areas due to existing site structures. Underground structures must be able to withstand the high temperatures created with thermal heating of the subsurface.</p> <p>Treatment efficiency is directly</p>	<p>High</p> <p>High capital cost and medium O&M cost</p>

			needs to be heated to achieve target temperatures within the aquifer. Displacement also facilitates hydraulic control of nonaqueous phase liquid (NAPL) mobility.	related to the ability to install heater wells on tight spacing.	
	Thermal Conductive Heating (TCH) West Area Only	TCH is an in-situ conductive thermal process used to heat the target zone to around the boiling point of water. A continuous sealed steel casing is installed across the target treatment zone. A heater element is installed within the steel casing. Ceramic insulators are used to electrically isolate the heating element from the casing. From the heater element, radiant heat is transferred to the well casing, and from the steel well casing, heat is subsequently transferred to the surrounding subsurface materials. Sustained heating will result in vaporization of water within the soil matrix. During this process, water and vapor are extracted through a SVE system to maintain hydraulic and pneumatic control, and to remove the COPCs mobilized by the heating through vaporization and extraction in the vapor phase. Thermal remediation technologies can successfully treat soils impacted with a wide range of volatile and semi-volatile contaminants including dense nonaqueous phase liquids (DNAPLs), light nonaqueous phase liquids (LNAPLs), polychlorinated biphenyls (PCBs), dioxins, pesticides, chlorinated solvents, tars, polynuclear aromatic hydrocarbons (PAHs), explosives residues, and mercury.	High TCH works in tight soils, clay layers, and soils with wide heterogeneity in permeability or moisture content that are impacted by a broad range of volatile contaminants. The conductive heating process is uniform in its vertical and horizontal sweep. At high temperatures, contaminant transport can be enhanced by the shrinking and cracking (desiccation) of soil near the heater wells. Preferential flow paths are created even in tight silt and clay layers, allowing flow and capture of the vaporized contaminants. TCH can be augmented with steam for sites with some higher conductivity zones. In the post-treatment stage, enhanced microbial degradation has been observed at sites where thermal treatment has been implemented.	Medium Generally can be implemented in the west area. Implementability would be low in some areas due to existing site structures. Underground structures must be able to withstand the high temperatures created with thermal heating of the subsurface. Treatment efficiency is directly related to the ability to install heater wells on tight spacing.	High Depends on energy use and length of time. Typically, thermal technologies are implemented quickly and result in decreased O&M duration. Production of off-gas would require a SVE system with vapor treatment equipment.
Excavation and Disposal/Reuse	Excavation and offsite disposal to Resource Conservation and Recovery Act (RCRA) Subtitle C or Subtitle D landfill West Area Only	Remove material for disposal in permitted landfill.	High Removal of source area will eventually reduce the COC concentrations in groundwater.	Low Would require significant (~50-foot) excavations that are not practical given the proximity to adjacent property and the river.	High

Figures

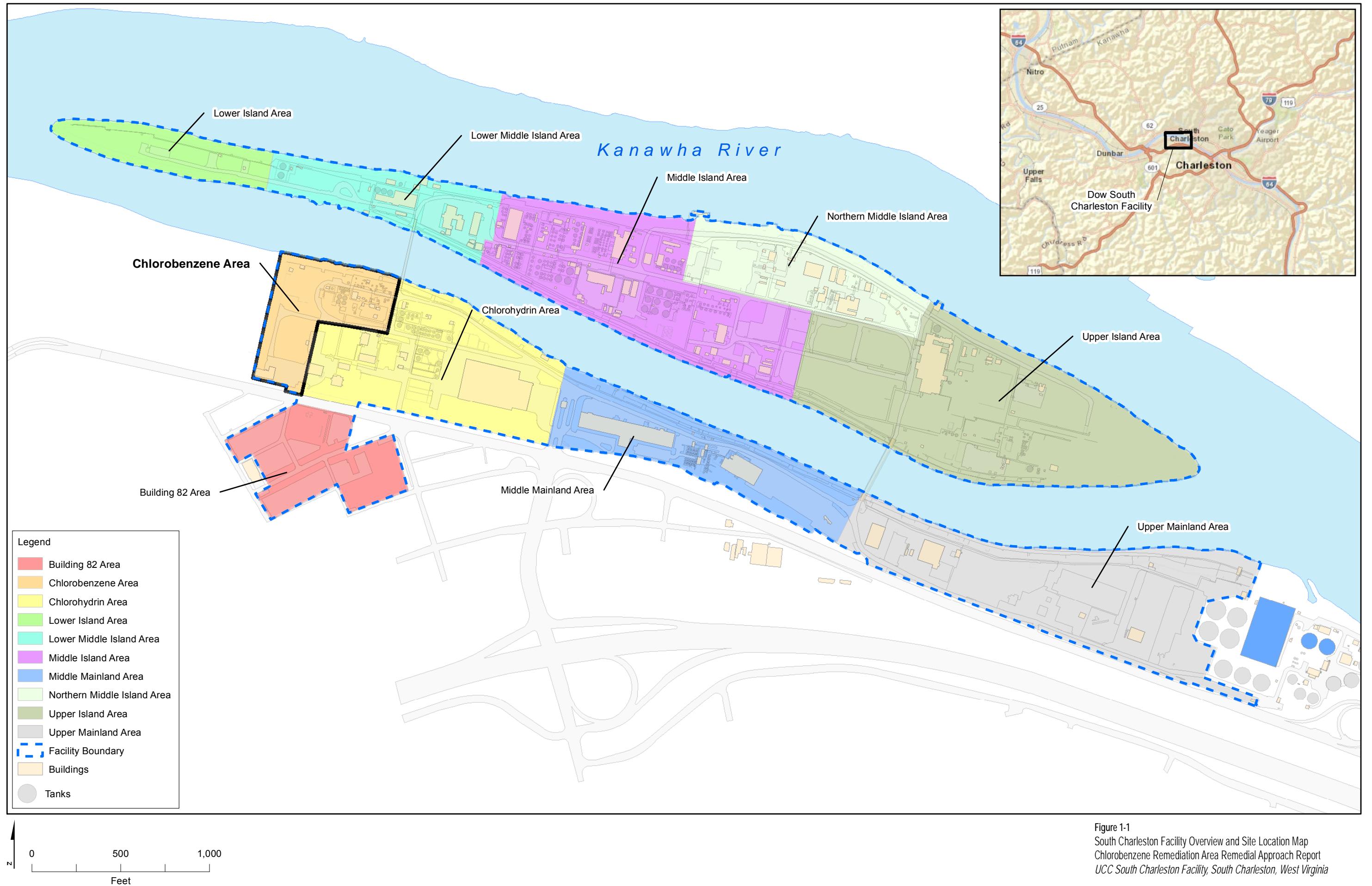


Figure 1-1
South Charleston Facility Overview and Site Location Map
Chlorobenzene Remediation Area Remedial Approach Report
UCC South Charleston Facility, South Charleston, West Virginia

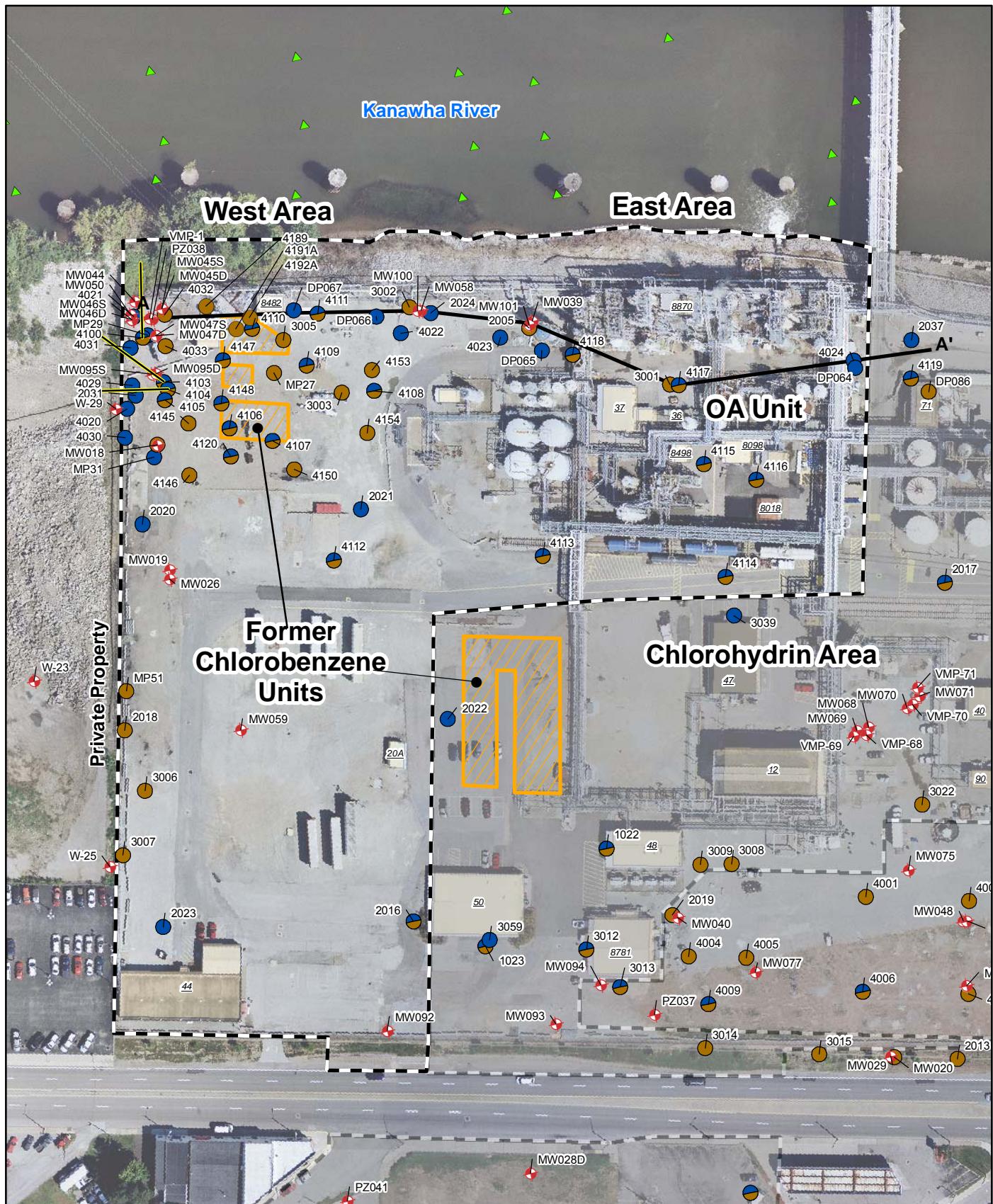


Figure 2-1
Chlorobenzene Remediation Area and Site Layout
Chlorobenzene Remediation Area Remedial Approach Report
UCC South Charleston Facility, South Charleston, West Virginia

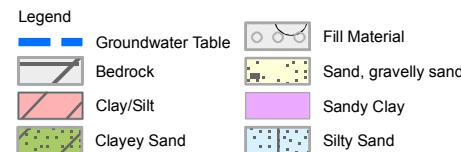
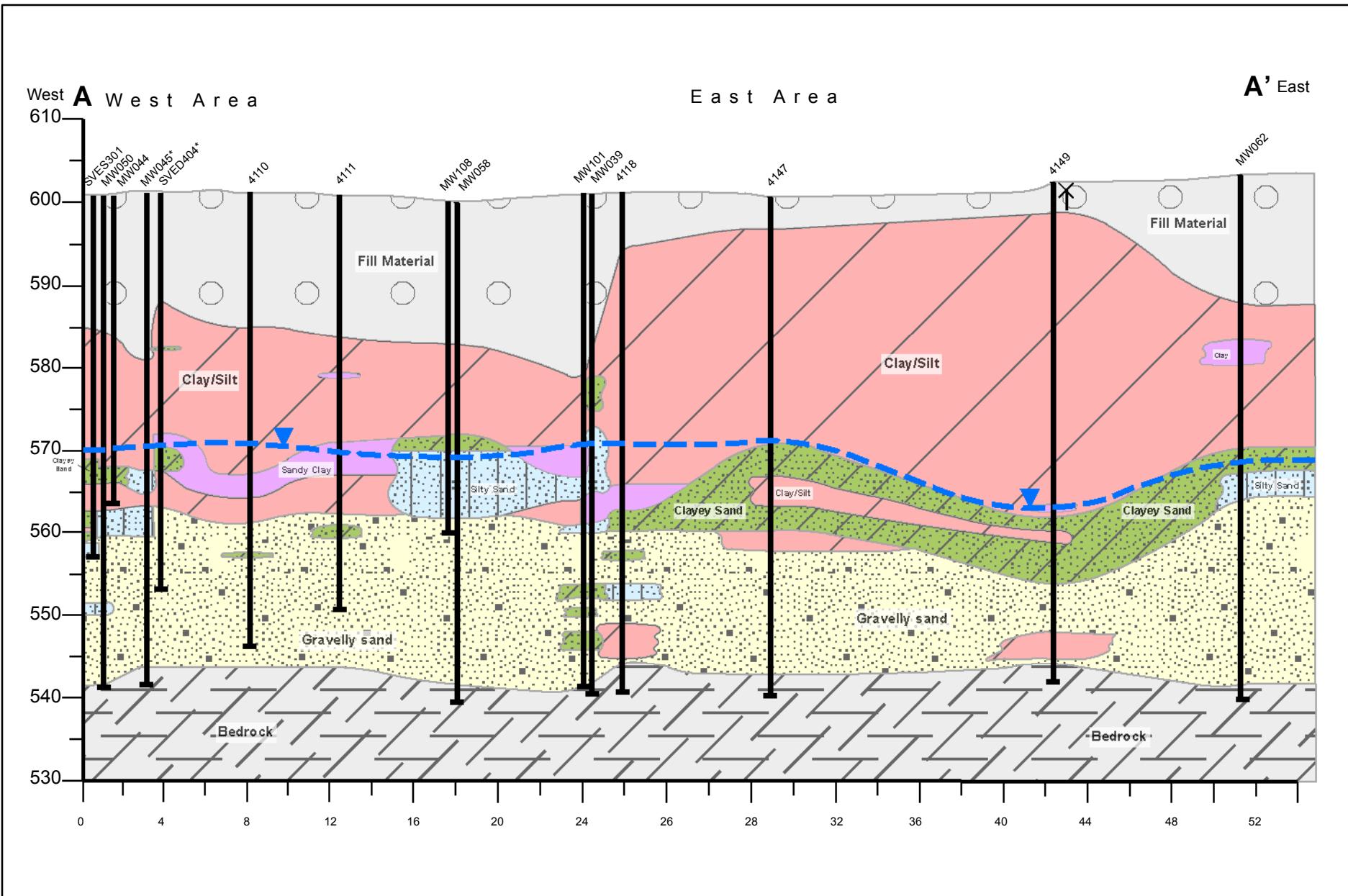


Figure 2-2
Cross Section A-A'
Chlorobenzene Remediation Area Remedial Approach Report
UCC South Charleston Facility, South Charleston, West Virginia

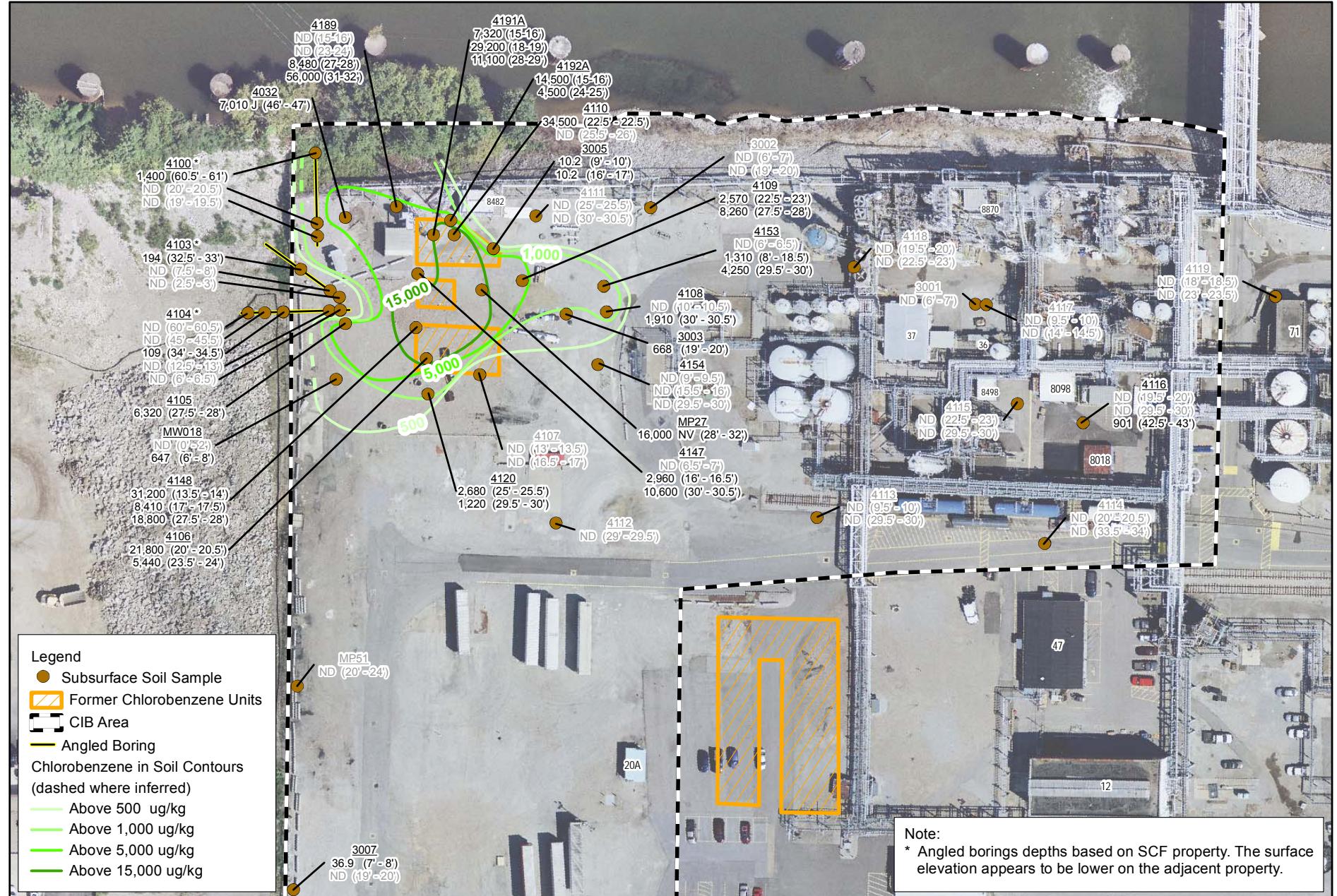


Figure 2-3
 Chlorobenzene in Soil
Chlorobenzene Remediation Area Removal Approach Report
UCC South Charleston Facility, South Charleston, West Virginia

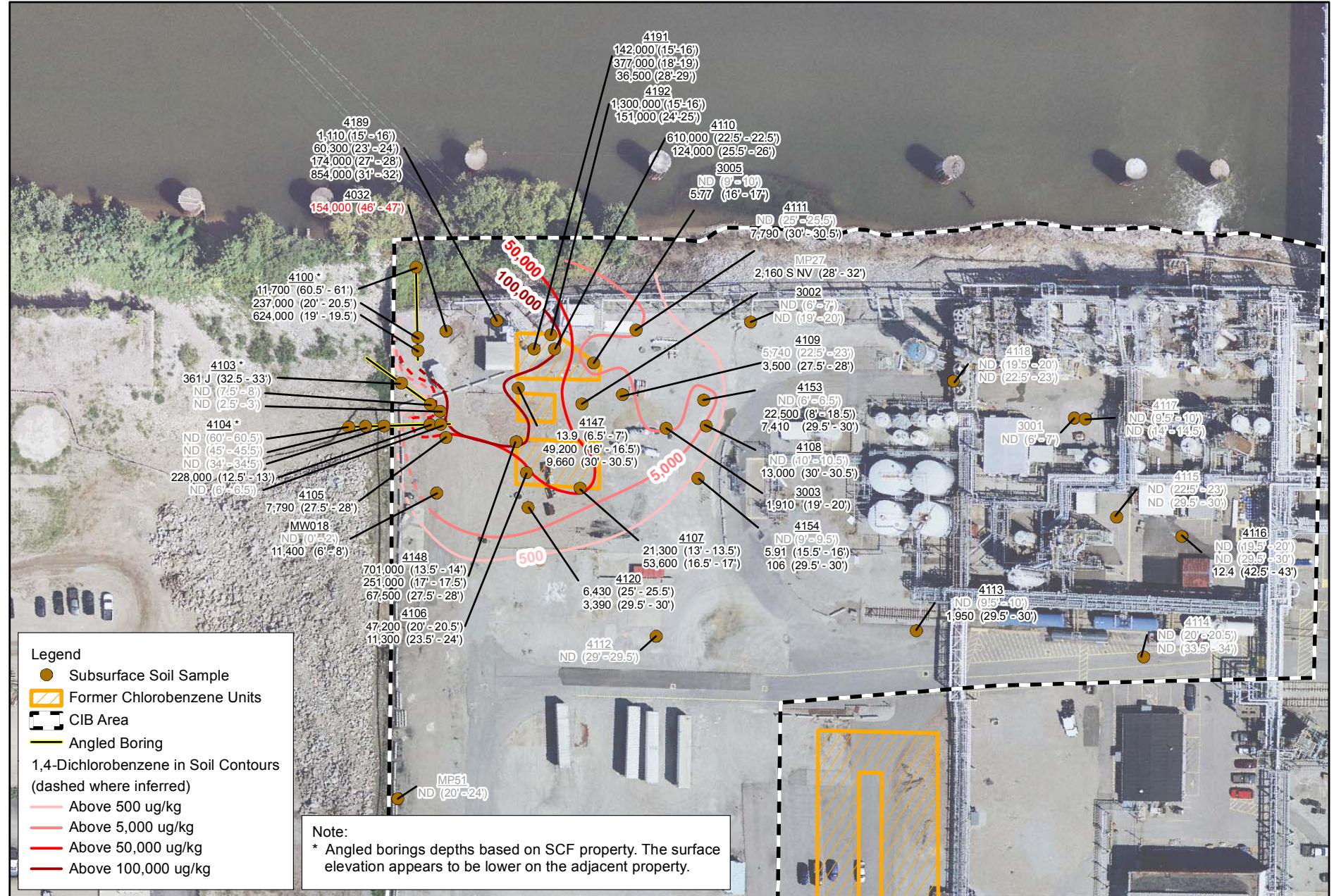


Figure 2-4
 1,4 - Dichlorobenzene in Soil
 Chlorobenzene Remediation Area Remedial Approach Report
 UCC South Charleston Facility, South Charleston, West Virginia

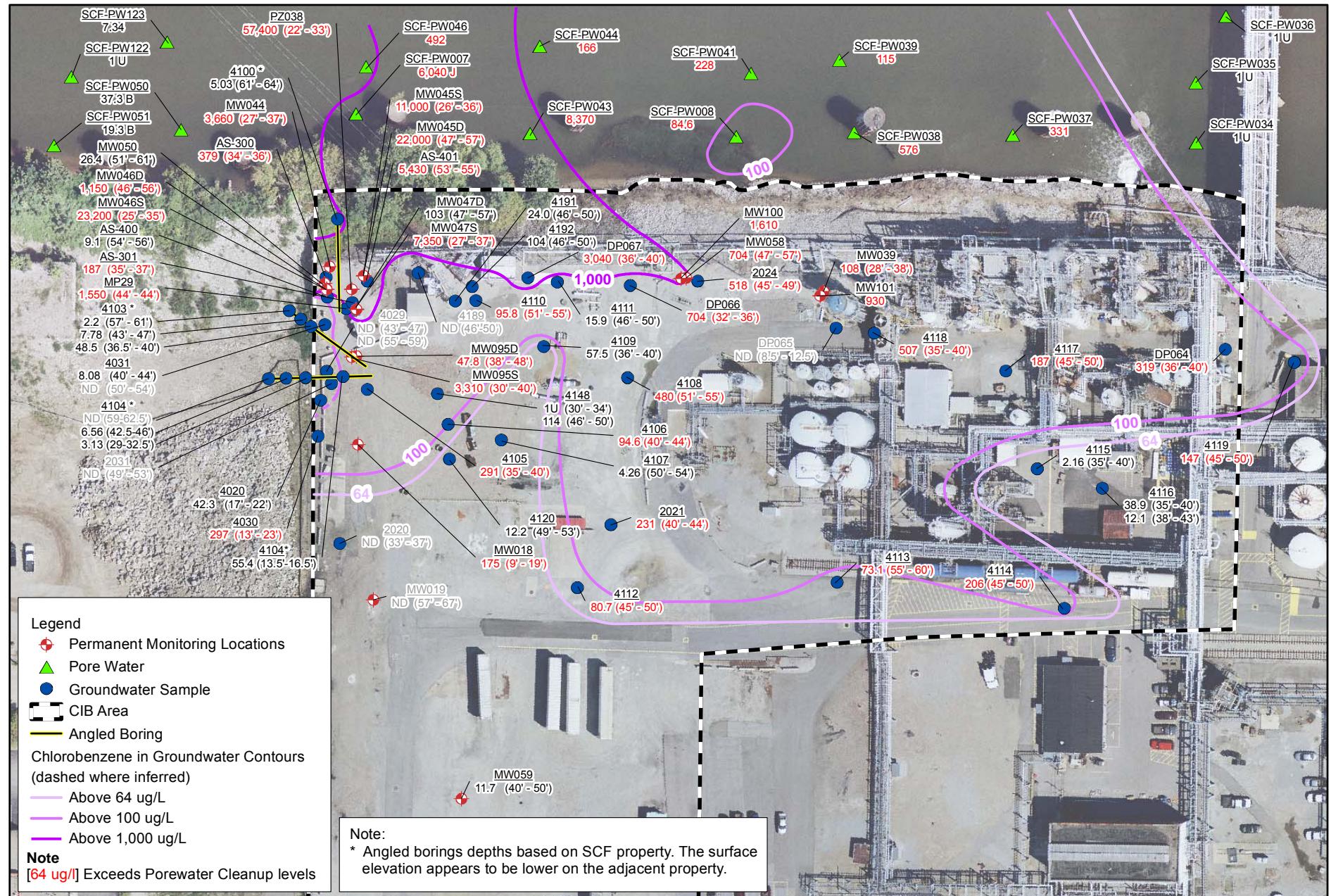


Figure 2-5
Chlorobenzene in Groundwater
Chlorobenzene Remediation Area Remedial Approach Report
UCC South Charleston Facility, South Charleston, West Virginia

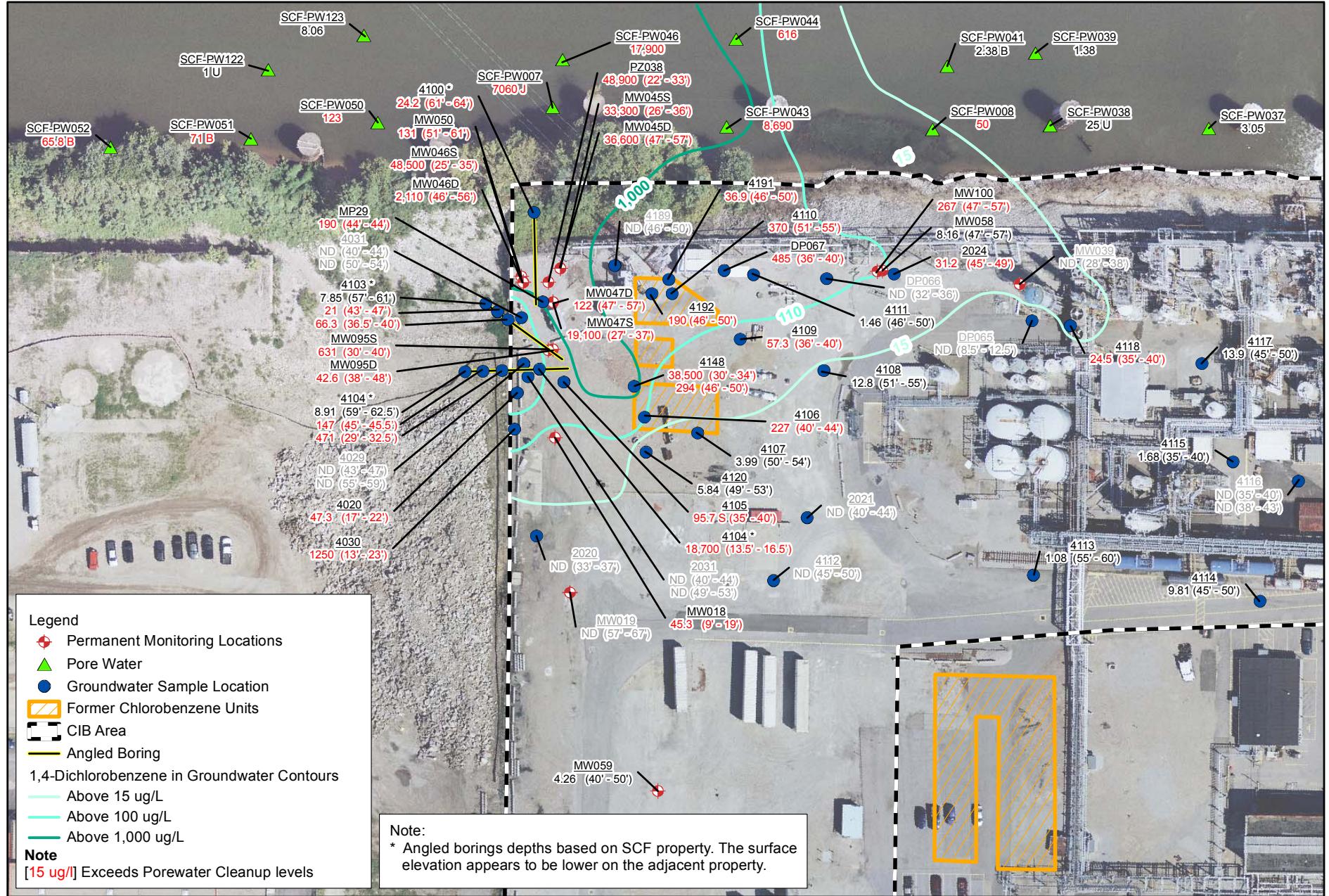


Figure 2-6
1,4-Dichlorobenzene in Groundwater
Chlorobenzene Remediation Area Remedial Approach Report
UCC South Charleston Facility, South Charleston, West Virginia

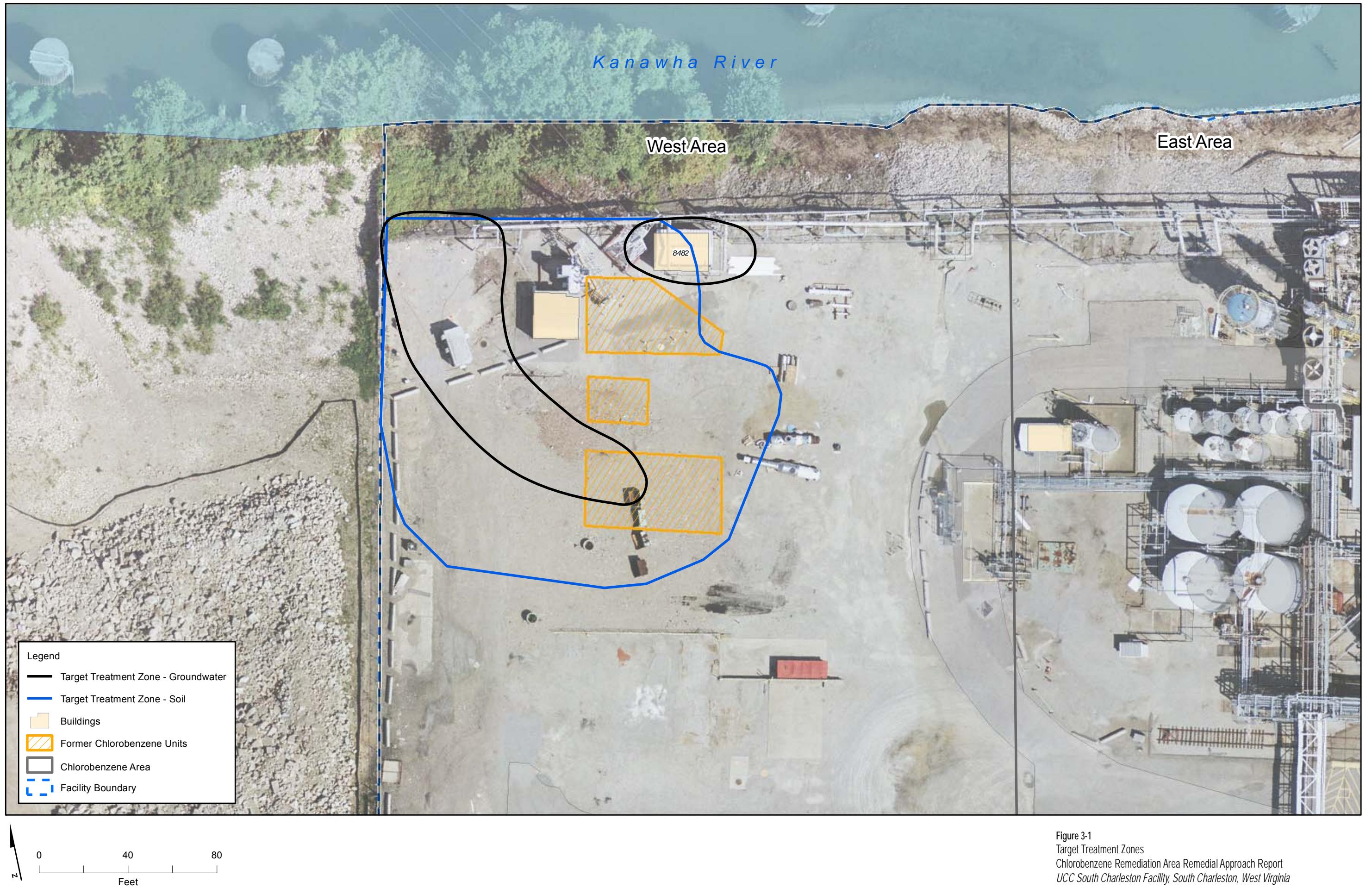


Figure 3-1
Target Treatment Zones
Chlorobenzene Remediation Area Remedial Approach Report
UCC South Charleston Facility, South Charleston, West Virginia

